Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JANUARY, 1953

TECHNOLOGY DEPT.

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JAN 30 1953
DETROIT

modern high-speed COLD MILLS designed and built by MESTA

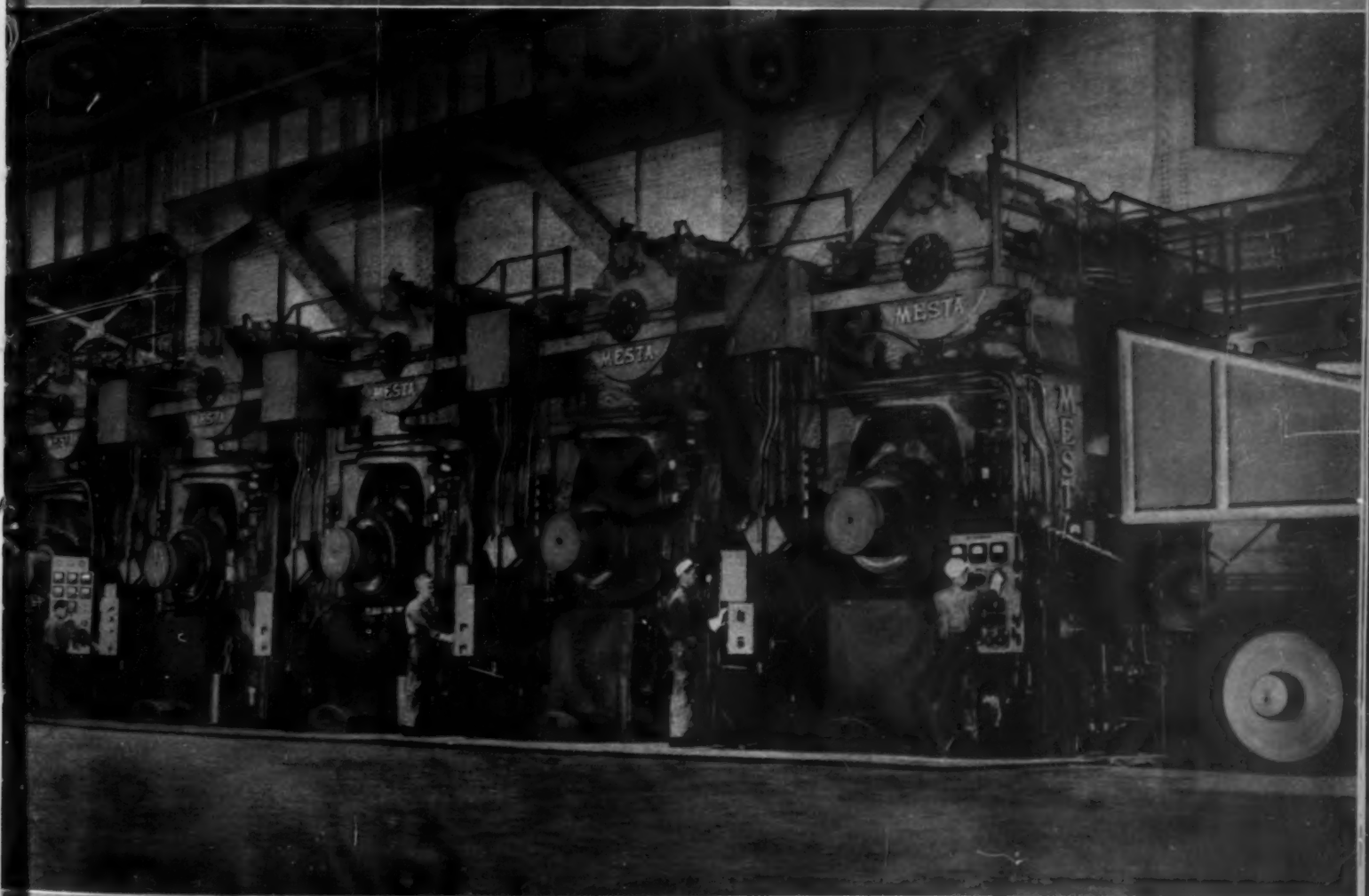


Photo by E. D. MESTA

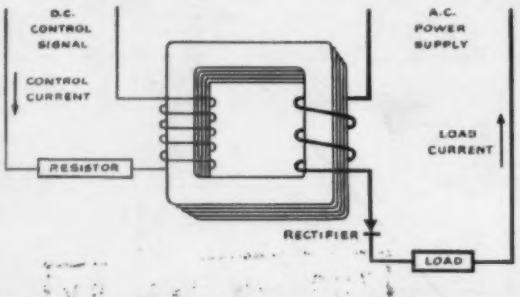
The World's Highest Speed Cold Mill . . . Mesta 42" Four-High, Five-Stand Tandem Cold Mill installed at Jones & Laughlin Steel Corporation, Aliquippa Works

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY · PITTSBURGH, PA.

R V.30 Jan.-June 1953

THE APPLICATION OF MAGNETIC AMPLIFIERS TO STEEL MILL CONTROL CIRCUITS



THE MAGNETIC AMPLIFIER

The magnetic amplifier as a motor control component has taken the electrical world by storm. Here is a unit that is simple in construction, that has no moving parts to wear out or get out of order . . . yet when properly designed and constructed and when properly engineered into a control scheme is capable of some of the most amazing control functions. Its response is swift, measured in a fraction of a second. It is accurate. It is immune to vibration and shock. Because of numerous installations Cutler-Hammer engineers have the knowledge and experience to properly apply the magnetic amplifier to control circuits of every kind.

Cutler-Hammer's practical knowledge of this newly useful component assures correct and efficient solution of your control problems.

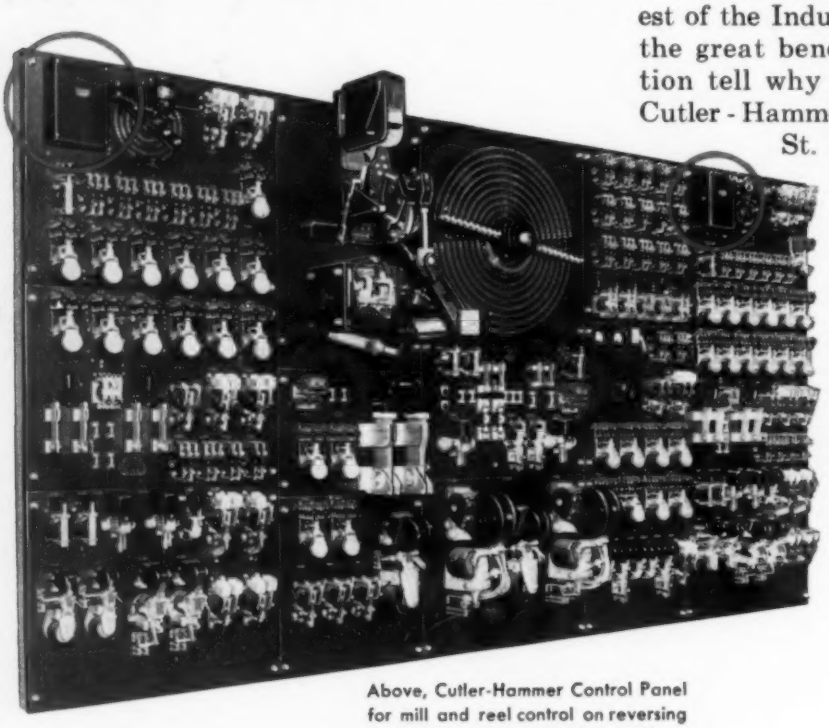
With a background experience gained by more than 50 years' intimate contact with the control problems of the Steel Industry, Cutler-Hammer engineers now bring to the Industry the knowledge and practical benefits of recent developments of the magnetic amplifier. The simple electrical and mechanical construction, the absence of moving parts, the tremendous versatility, the immunity to shocks and vibration, and the dependability of the magnetic amplifier recommend it to any steel mill man seeking higher production, better performance and more uniform operation in a wide variety of mill applications. If you have a problem involving:

Tension control	Acceleration
Voltage regulation	Positioning
Speed control	or any combination of these,

bring it to Cutler-Hammer.

The adaptability which the magnetic amplifier has in its performance characteristics and the need for skilled engineering experience of the subject are factors that suggest its application by men *competent* to do so.

Versatility and dependability explain the great interest of the Industry in this new method of control; and the great benefits derived from its proper application tell why experienced mill men are coming to Cutler-Hammer. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin.
Associate: Canadian Cutler-Hammer, Ltd., Toronto, Ontario.



Above, Cutler-Hammer Control Panel for mill and reel control on reversing strip mill, utilizing magnetic amplifiers.

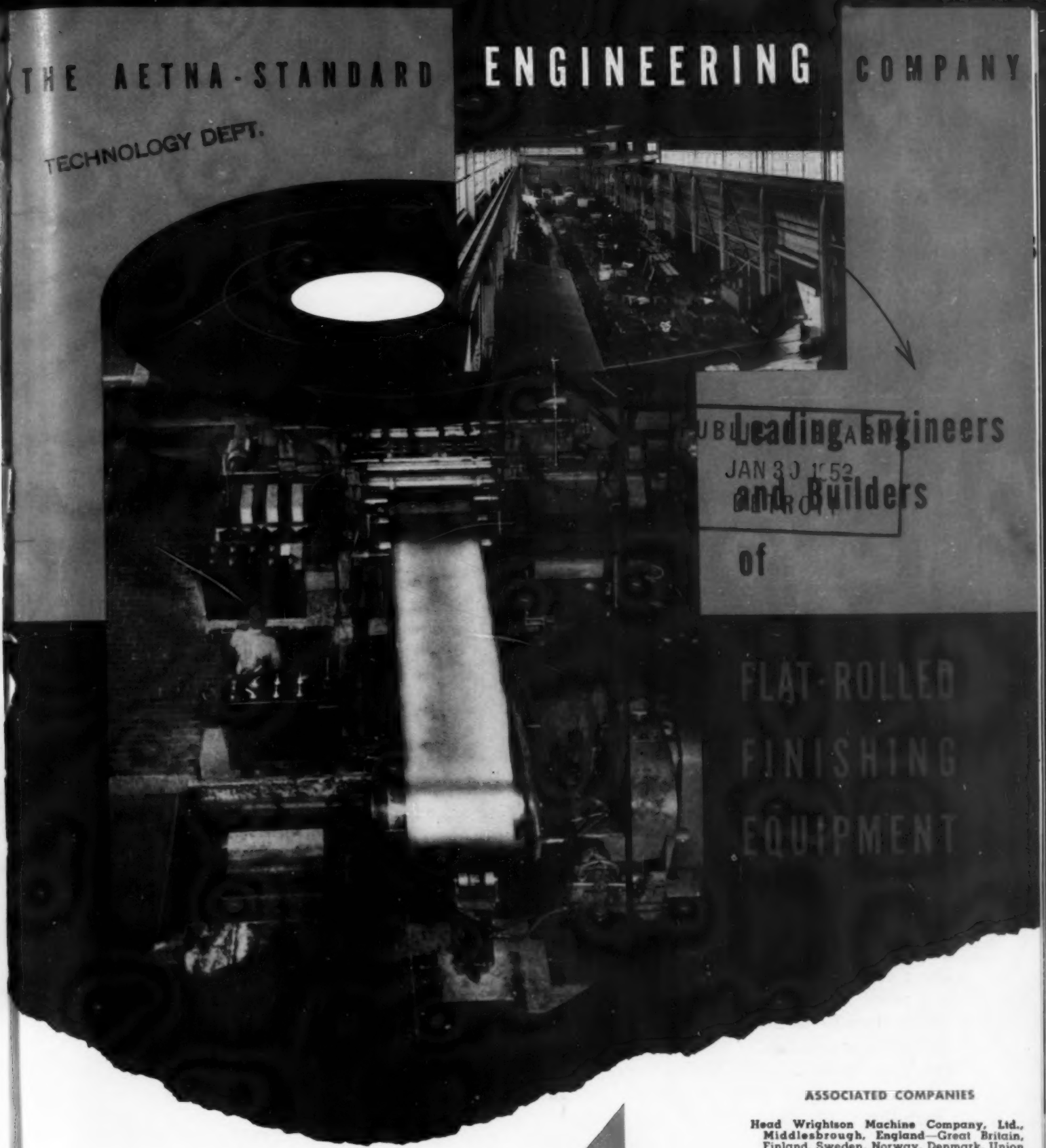
CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 30, No. 1.

Tech.

THE AETNA-STANDARD ENGINEERING COMPANY

TECHNOLOGY DEPT.



Leading Engineers and Builders of

FLAT-ROLLED FINISHING EQUIPMENT

JAN 30 1952

ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England—Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Castellvi, Inc., New York, N. Y.—Mexico, Central and South America.

Societe de Constructions de Montbard, Paris, France—France, Belgium, Holland, Luxembourg, Switzerland.

Demag Aktiengesellschaft, Duisburg, Germany—Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.

Compagnia Italiana Forme Acciaio, Milano, Italy—Italy.

Aetna-Japan Company, Ltd., Tokyo, Japan—Japan.

Hale & Kullgren, Inc., Akron, Ohio—Representative for the Rubber Industry.

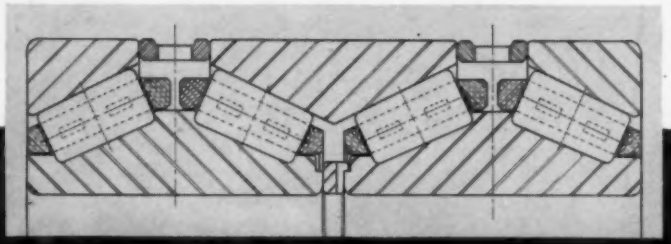
Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries

Aetna-Standard

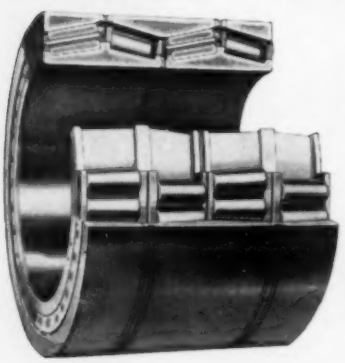
THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Plants in Warren, Ohio · Ellwood City, Pennsylvania

TORRINGTON Four-Row Tapered Roller Bearings on finishing-stand work-rolls of U. S. Steel 80" hot-strip mill were specially designed for high thrust loads.



Rolling to a new



world's record!

2,621,500 net tons of 2000-foot coils of uniform strip! That was the world's record rolled in 1951 by U. S. Steel's 80" hot-strip mill—on TORRINGTON Tapered Roller Bearings.

Precision-ground TORRINGTON Tapered Roller Bearings are used on many of the work-roll and back-up thrust positions, from the huge mill's No. 1 scale breaker to its finishing stands.

These TORRINGTON Bearings, say U. S. Steel engineers, have given excellent service. Specially designed by TORRINGTON to withstand the high thrust loads developed, they have helped to cut down-time to only one hour a turn.

Get more tons per turn from *your* mills. Equip them with TORRINGTON Tapered Roller Bearings.

THE TORRINGTON COMPANY

South Bend 21, Ind. Torrington, Conn.

TORRINGTON TAPERED ROLLER **BEARINGS**

Spherical Roller • Needle • Tapered Roller • Straight Roller • Ball • Needle Rollers

TRANTINYL

guides the steel industry

YOUNGSTOWN ALLOY CASTING CORP., • YOUNGSTOWN, O.

ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc.
ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

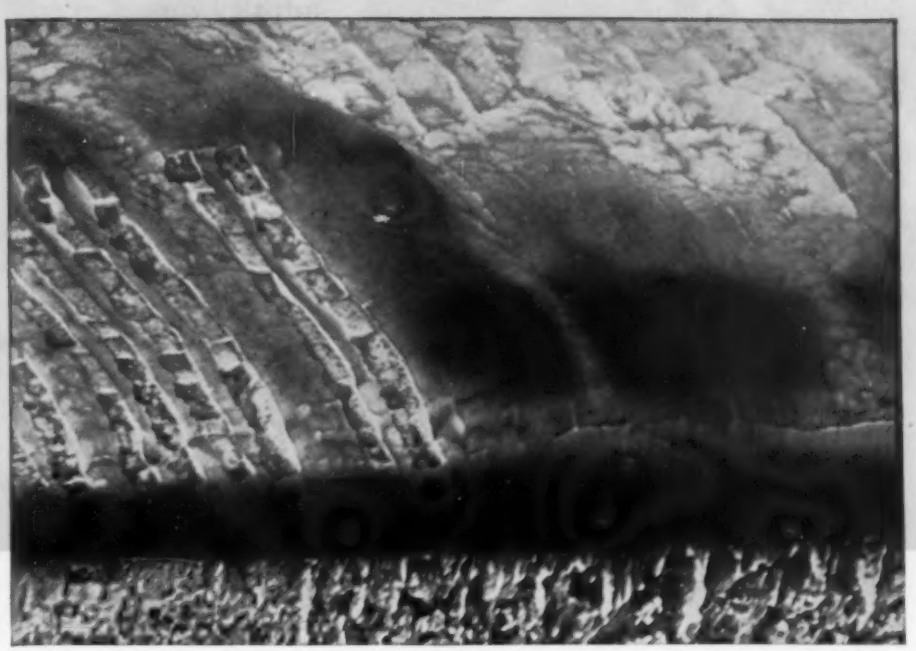
Stripes of Superiority

Survival of the fittest is the rule of the jungle. And so it is with refractories in the critical areas of the nation's open-hearth furnaces.

Convincing proof that Zebra roofs with Grefco's STEELKLAD-40 are tops in zones of greatest wear, has caused steel men to select STEELKLAD-40 in more than 9 out of 10 of existing Zebra roofs. Results often show more heats per campaign, reduced repairs—hence greater furnace availability.

STEELKLAD-40 is a patented unburned chrome-magnesite roof brick that is permanently jacketed in a steel shell which becomes an integral part of the brick itself. Developed in Grefco's modern research laboratories, STEELKLAD-40 is the major reason for the amazing increase in popularity of the open-hearth Zebra roof.

In service the STEELKLAD-40 key brick protrude beyond and protect the silica brick from destructive gases. The silica brick



make possible a strong, mechanically stable roof. Note the illustration above. The dark area to the right consists of plain silica construction. The silica brick are ready for a patch. Yet the Zebra section is still in good condition.

Surveys have proved that the Zebra roof has gained industry popularity faster than any other construction in open-hearth history. More and more steel men are calling on Grefco to help solve roof problems with STEELKLAD-40.

Remember, too, Grefco's STEELKLAD basic brick also provide superior service in front and back walls, monkey walls and furnace ends. Whether it's STEELKLAD, fireclay, silica, high alumina or RITEX basic brick . . . mortars, plastics, castables and specialties . . . Grefco serves steel with a truly *complete refractories service*. Call on us!

GENERAL REFRACTORIES COMPANY
PHILADELPHIA

GENERAL REFRACTORIES

Stopping rust with Rust-Oleum 769 Damp-Proof Red Primer
... for double protection use Rust-Oleum finish coatings
available in many colors, aluminum and white

RUST-OLEUM®

STOPS RUST!

Just scrape and wirebrush to remove rust scale and loose particles . . . then brush Rust-Oleum 769 Damp-Proof Red Primer *directly over the sound rusted surface.* Chemical pre-cleaning and other costly preparations are *not* usually required. Rust-Oleum finish coats in many colors provide *double protection.* Specify Rust-Oleum . . . prompt delivery from Industrial Distributor stocks in principal cities.

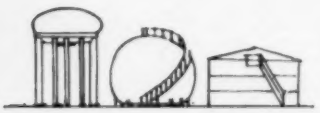
RUST-OLEUM CORPORATION
2441 Oakton Street, Evanston, Illinois

Applied by brush, dip, or spray.

FREE SURVEY: Ask a Rust-Oleum specialist to conduct a survey including actual applications, tests, and recommendations. No cost or obligation. See Sweets for nearest Rust-Oleum distributor or write for literature today.

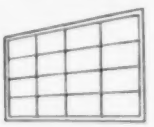
...proved throughout industry for over 25 years

Such fields as Petroleum, Marine, Railroad, Mining, Agricultural, Steel, General Industry are but a few who rely upon Rust-Oleum. General weathering, heat, chemicals, salt water atmosphere, fumes, etc., are only a few of the conditions resisted by Rust-Oleum.

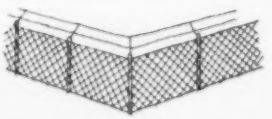


Water tanks, gas tanks, fuel tanks—Rust-Oleum protects your investment.

One truck, or a fleet of trucks, applied over rust, Rust-Oleum keeps them looking better . . . in service longer.

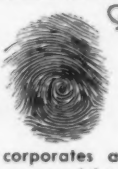


Metal sash and steel windows, roofs, gutters, fire escapes, railings—indoors and out need Rust-Oleum to stop rust.



Wire fence maintenance? Rust-Oleum's Extra-Long Nap Lamb's Wool Roller cuts re-coating costs up to 50% in some cases.

There is Only One Rust-Oleum



Rust-Oleum is an *exclusive formula* developed by a Master Mariner during more than 20 years battling actual rust conditions at sea. It incorporates a *specially-processed* fish oil vehicle that will *dry*, is *odor-free*, and is formulated in *many colors.* Be sure you specify genuine Rust-Oleum. Accept no substitute.

ATTACH TO YOUR LETTERHEAD-MAIL TODAY!

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2441 Oakton St., Evanston, Illinois

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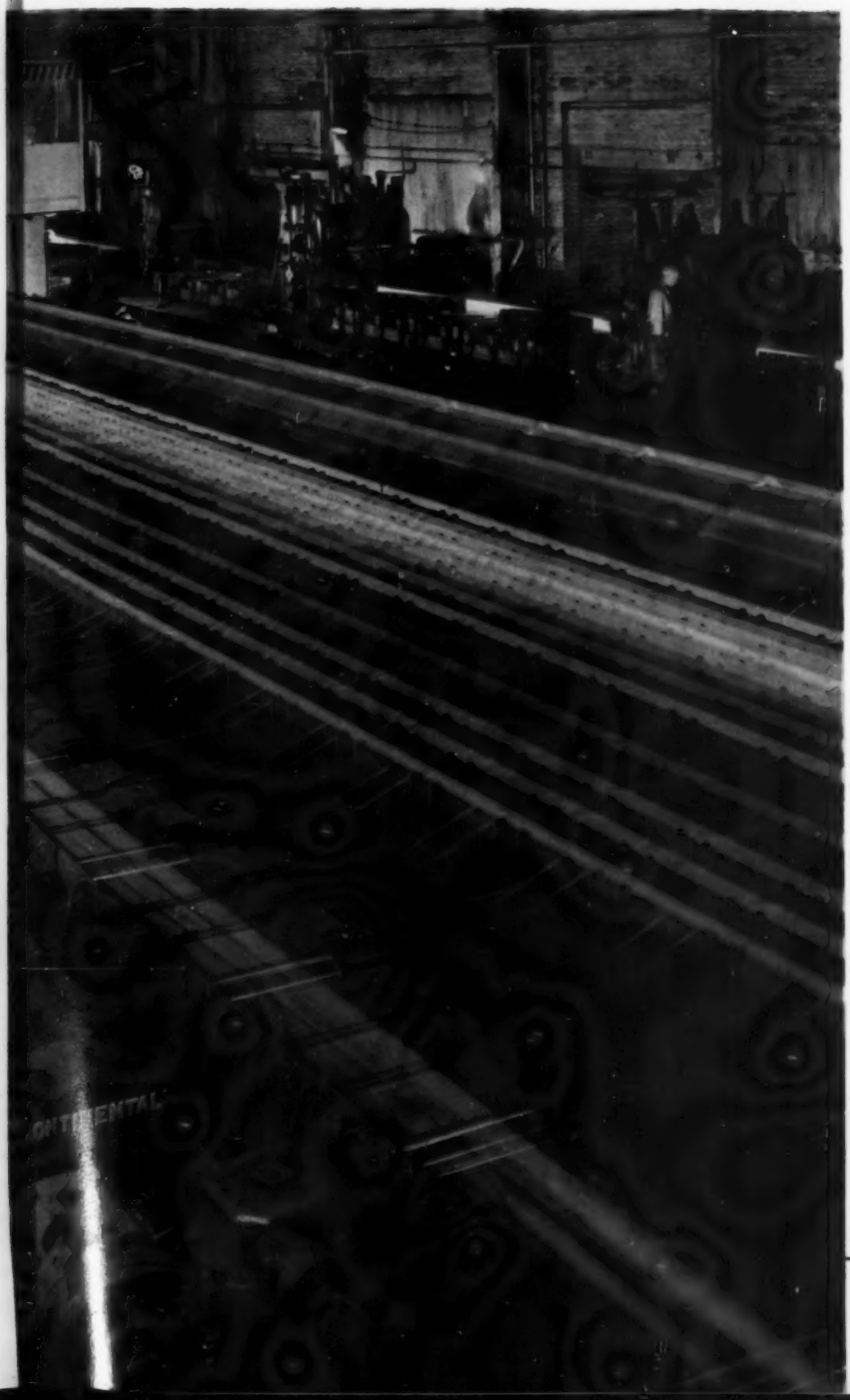
- ☐ Free Survey
- ☐ Complete Literature
- ☐ Nearest Source of Supply

CONTINENTAL

MERCHANT BAR MILL



Rolling Mill installations engineered complete

for steel, alloy and
non-ferrous metals

BLOOMING MILLS
STRUCTURAL MILLS
RAIL MILLS
BILLET MILLS
ROD MILLS
BAR MILLS
MERCHANT MILLS

★ ★ ★

SLABBING MILLS
UNIVERSAL MILLS
PLATE MILLS
HOT STRIP MILLS
COLD STRIP MILLS
TEMPER MILLS

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Mills complete with
Auxiliary Equipment

★ ★ ★

ROLL LATHES
CONTINENTAL CHIPPER
SPECIAL MACHINERY

★ ★ ★

CASTINGS—carbon
and alloy steel
from 20 to 250,000
pounds

ROLLS—iron, alloy
iron and steel
rolls for all types of
rolling mills

WELDMENTS—fabricated
steel plate, or
cast-weld design

* * *

CHICAGO • PITTSBURGH

Plants at:
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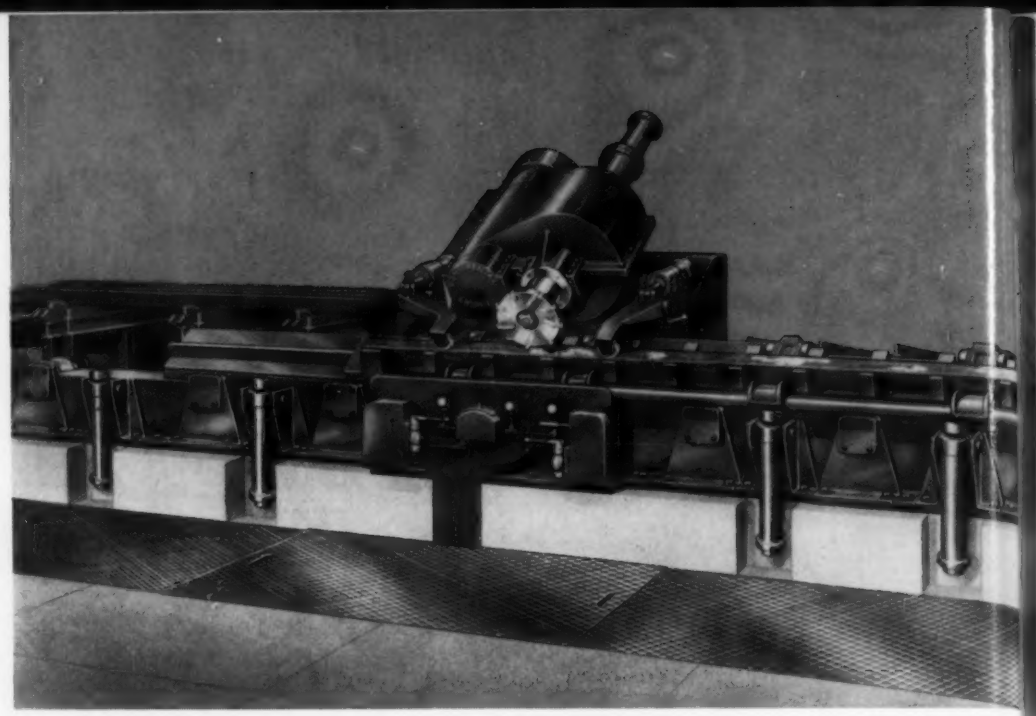
CONTINENTAL
Foundry & Machine
Company

CONTINENTAL
CHIPPER

Mechanical surface conditioning for all types of blooms, billets and slabs from 1½″ to 12″ sections; lengths up to 40′, in all analyses including carbon, alloy and stainless steel. One man operated, the Continental Chipper features a direct motor drive with hydraulically adjusted chipping head, planer type bed and hydraulic manipulation of the work at any position. Standard installation includes mechanically operated feed bed and discharge skids. Augmented installations including a billet unscrambler and inspection and marking car available for high production requirements.



CONTINENTAL
HEAVY DUTY ROLL LATHES

Available in seven standard sizes for body turning, necking and ragging all types of rolls from Rod Mill rolls to largest Plate Mill back-up rolls. Furnished as standard with single headstock and tandem housings for rough turning on centers and finish turning and grooving in housings. All sizes are also available with double headstock, hydraulic tool feed and ragging attachments. D. C. driven headstocks feature two speed ranges by syncromesh gear shift; A. C. operation is provided by a four-speed motor. All headstock gearing is totally enclosed and oil lubricated. Worm and double helical gearing is standard.

* * *

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Plants at:
East Chicago, Ind.
Wheeling, W. Va.
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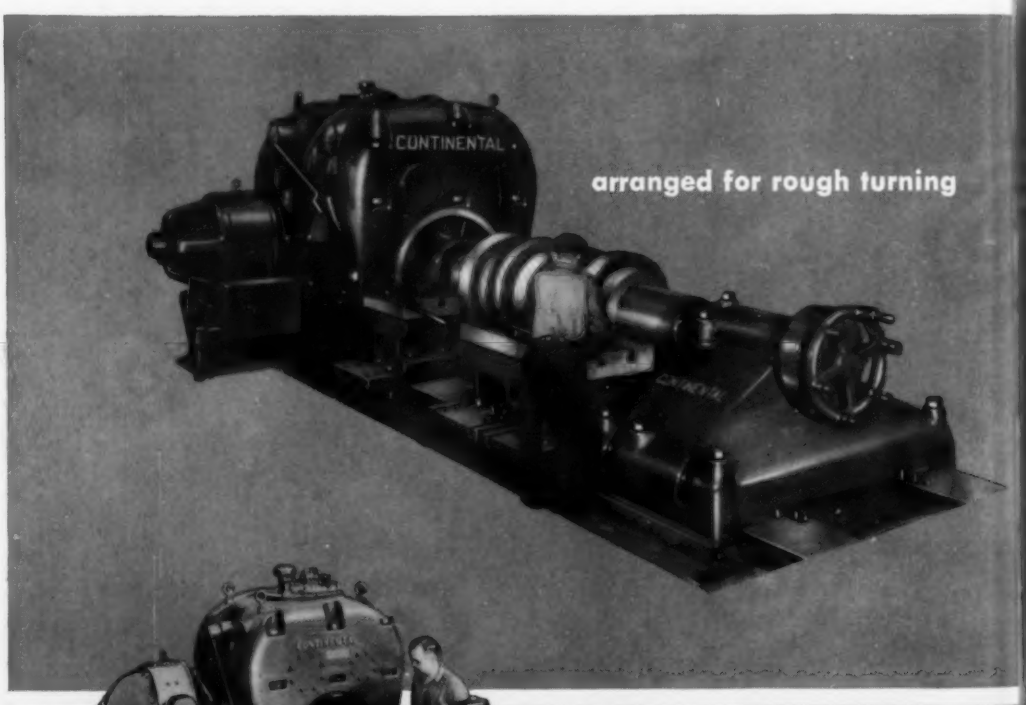
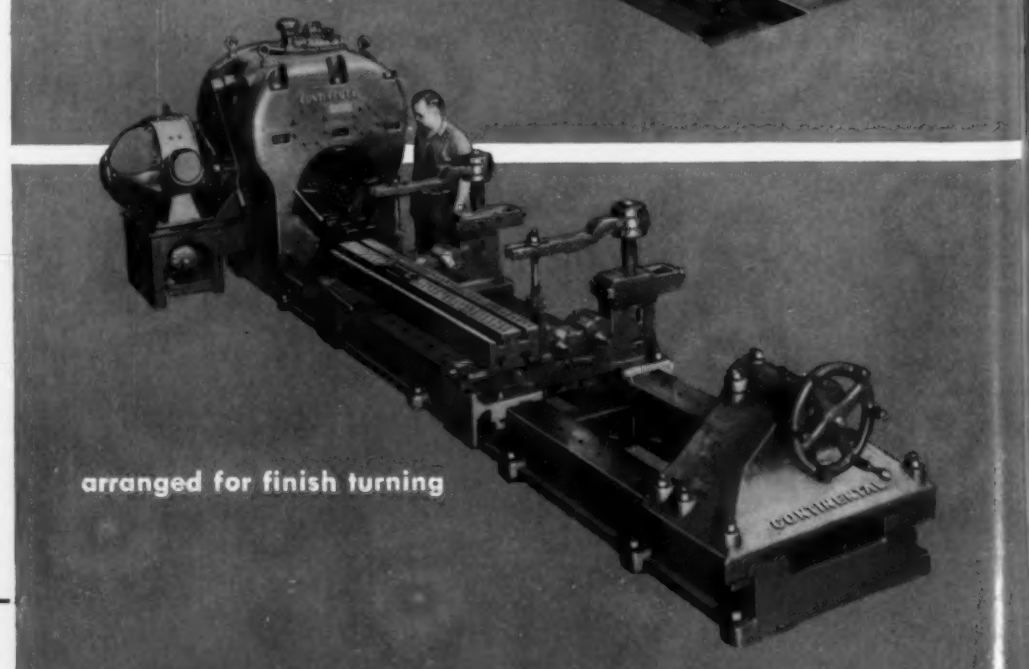


arranged for rough turning



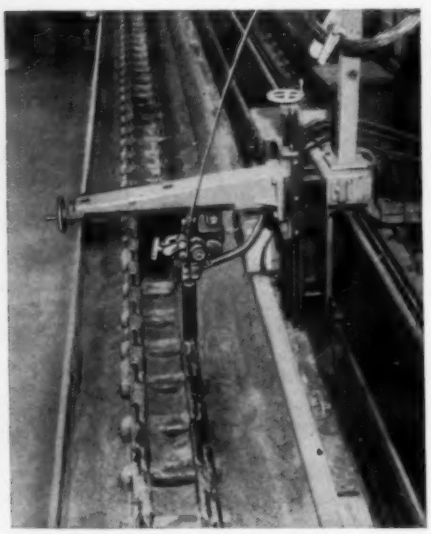
arranged for finish turning

LINDE'S News of Metalworking

Worn Parts Rebuilt Economically by UNIONMELT Welding

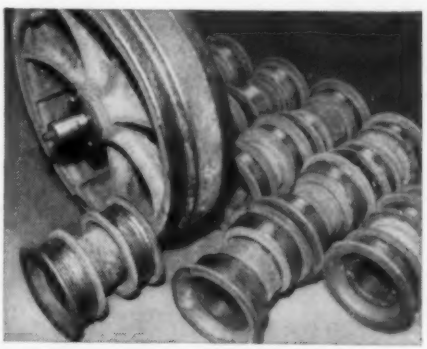
Repair of worn tractor parts is most practical and economical with specially developed fixtures on which standard UNIONMELT welding units are mounted. The metal deposited by UNIONMELT welding is so smooth that no grinding or finishing is required. Experience indicates that resurfaced areas will wear as long as new parts.

The Berkeley "Conservall" fixture is designed especially for rebuilding crawler tractor track links or rails without disassembling them. The track is placed in a trough and clamped in position. A LINDE side-beam carriage moves the UNIONMELT welding equipment over the positioned track and the welding of each link is automatically started, stopped, and accurately controlled. Rollers, idlers, sheaves, and other circular work can also be welded or resurfaced on another section of the machine.



Tractor rail links rebuilt in "Conservall" machine by UNIONMELT welding. Cams automatically control welding action for each link.

The "Leader" machine is also available for rebuilding both cylindrical and flat parts. Rollers are rebuilt on top of the machine. Larger parts, such as idlers, are mounted in the chuck at the side of the machine as shown. With the flat work attachment, parts such as disassembled track rail links, grousers, bulldozer blades, end bits and fabricated members can be resurfaced easily. This attachment is operated by a gear which is mounted in the chuck.



These tractor rollers and an idler were rebuilt at a speed of 30 in. per min. by UNIONMELT welding.

With both machines, the wheels can be tilted for rebuilding the flanges. It takes only 80 to 90 minutes to rebuild a D-8 track roller. Idlers take about three times as long.

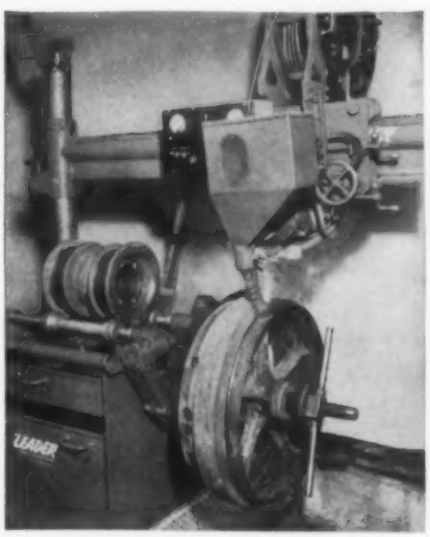
OXWELD 1928 rod is normally used in making these repairs. When wear is excessive, OXWELD 296 rod is sometimes used for the initial buildup which is then finished with OXWELD 1928 rod. For such resurfacing, use either Grade 80 or Grade 90 UNIONMELT welding compositions.

For some services, a finishing pass with a higher alloy tube rod is applied to produce a harder surface. While material of almost any hardness can be applied, one combining hardness and toughness lasts longer than one of higher hardness that tends to spall and chip. As deposited, OXWELD 1928 material has a hardness of about Rockwell C-25, but in service the working surfaces actually develop properties which cause them to outwear deposits that are substantially harder.

Advantages of UNIONMELT Build-up

UNIONMELT welded resurfacing is especially attractive with these automatic machines which readily permit deposit rates of 20 lbs. per hour. Savings in time and the advantages of a smooth uniform deposit justify the initial investment in automatic equipment. Important in these times is the conservation of metal realized with the process. The use of approximately *one hundred pounds of weld metal saves replacement of 2,000 to 3,000 pounds of new parts.*

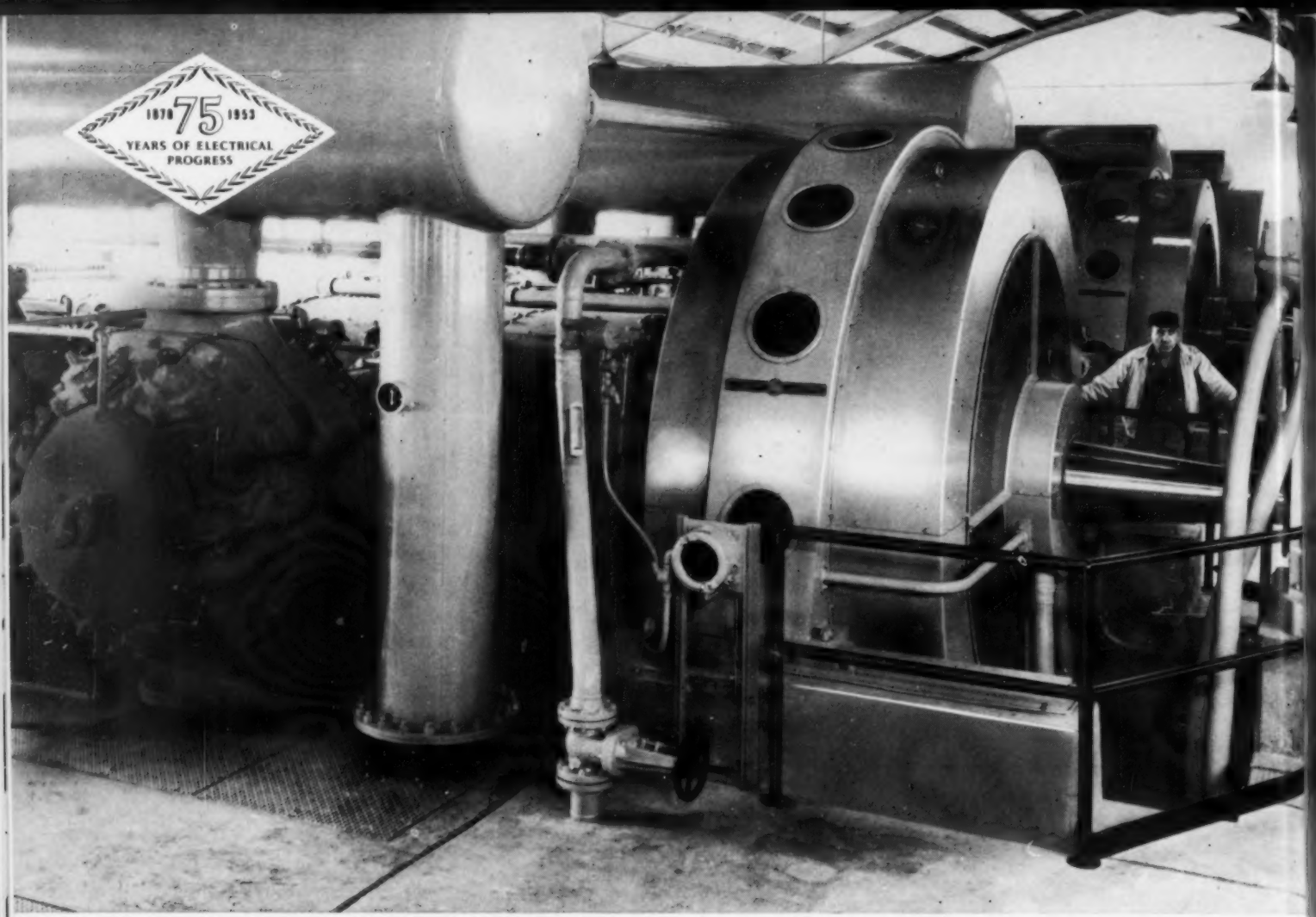
LINDE'S engineers and technicians will be glad to give further information about UNIONMELT welding. Telephone or write today.



UNIONMELT welding head on "Leader" fixture rebuilds rollers and idlers. Rollers are welded on top of the machine, idlers at the side, and flat parts, depending on their size, can be welded on top of the machine or in the flat work attachment.

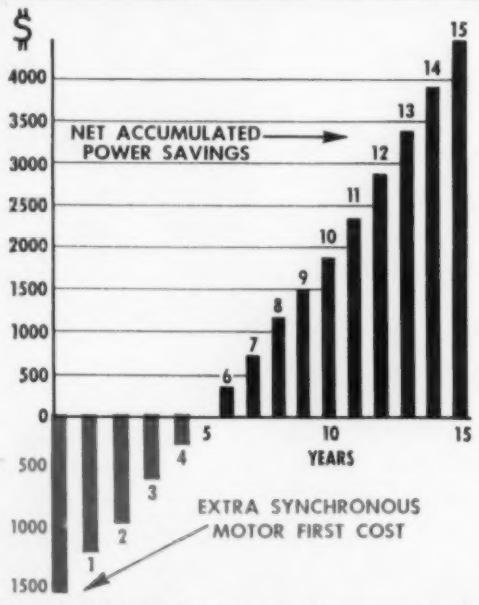
LINDE AIR PRODUCTS COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: Dominion Oxygen Company, Limited, Toronto

The terms "Linde," "Oxweld," and "Unionmelt" are registered trade-marks of Union Carbide and Carbon Corporation.



COMPRESSORS IN A GAS STORAGE STATION are driven by General Electric 3000 hp, 300 rpm synchronous motors.

Can synchronous motors cut

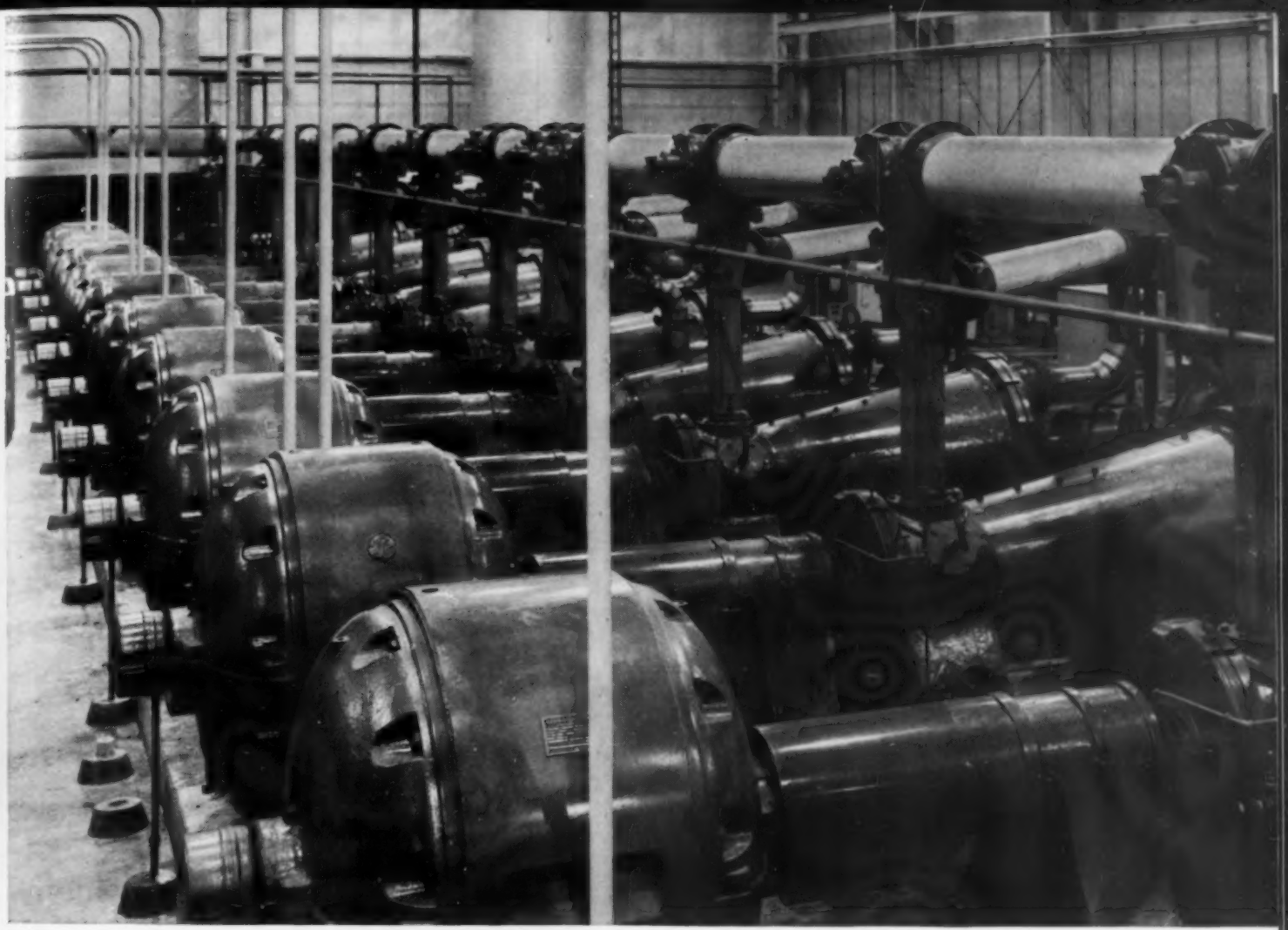


OPERATING SAVINGS on the synchronous motor application described above are shown over a period of twenty years. Extra first cost will be amortized in five years; savings will continue for many more.

Here's how one plant saves with a G-E Synchronous Motor

The specifications for a new pump motor were 250 hp, 600 rpm, 2300 volts, 3 phase, 60 cycle. The price of a 1.0 Power Factor synchronous motor, including exciter and control, was higher than an equivalent squirrel-cage induction motor with control. However, the synchronous motor efficiency, including exciter loss, was 1.6% higher than the induction motor (93.0% vs 91.4%). Since the motor was to operate continuously at a power cost of 11 mils per kilowatt-hour, it was found that the power savings would repay the additional investment in only five years. The operating savings will continue throughout the life of the motor—10, 20, even 30 years.

Savings such as these make synchronous motors the most economical drive for many heavy-duty, continuous-service applications. And in many cases, synchronous motors are lowest in first cost, too.



GENERAL ELECTRIC 400 HP SYNCHRONOUS MOTORS are coupled to ten Jordans in a paper mill.

your plant's operating costs?

Greater Efficiency on Large, Constant-Speed Applications Can Lower Power Costs Substantially

On certain applications selection of General Electric synchronous motors can bring about substantial savings in plant operating costs. Synchronous motors usually have a higher full-load efficiency than any other type of motor, produce more work per dollar's worth of power consumed.

Furthermore, synchronous motors may be able to improve plant power factor—the ratio of total kilowatt load to total kva load. When these two fall out of balance, high system losses, high power bills, or increased maintenance costs commonly result. Using a ***unity power factor*** synchronous motor adds only to total kw load. And, a ***leading power factor*** synchronous motor will actually supply reactive kva's to your system, while operating at its normal rated output.

Before you select a drive for a large piece of equipment providing heavy and continuous service, be sure to investigate the economics of General Electric synchronous motors. Call in your G-E representative—he'll be glad to discuss your situation with you. Also, information on G-E synchronous motors and their application is available in the following bulletins: GEA-5332, "Low-Speed Synchronous Motors;" GEA-5426, "High-Speed Synchronous Motors;" GEA-5817, "Plant Power Factor Improved With G-E Synchronous Motors." Write to Section 770-27, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

FROM THE TOP STEEL PRODUCER . . .

TO A LEADING CHEMICAL HOUSE,

A YEAST COMPANY

AND A MEAT PACKER . . .

Heat Prover SERVES 62 DIFFERENT COMPANIES IN THE GREAT CHICAGO INDUSTRIAL AREA!

The Cities Service Heat Prover is graphically proving its worth to all kinds of industry in the Chicago area and elsewhere throughout the country.

62 different companies, producing everything from steel to beef, have found the Heat Prover an important aid to increased production and big dollar economy.

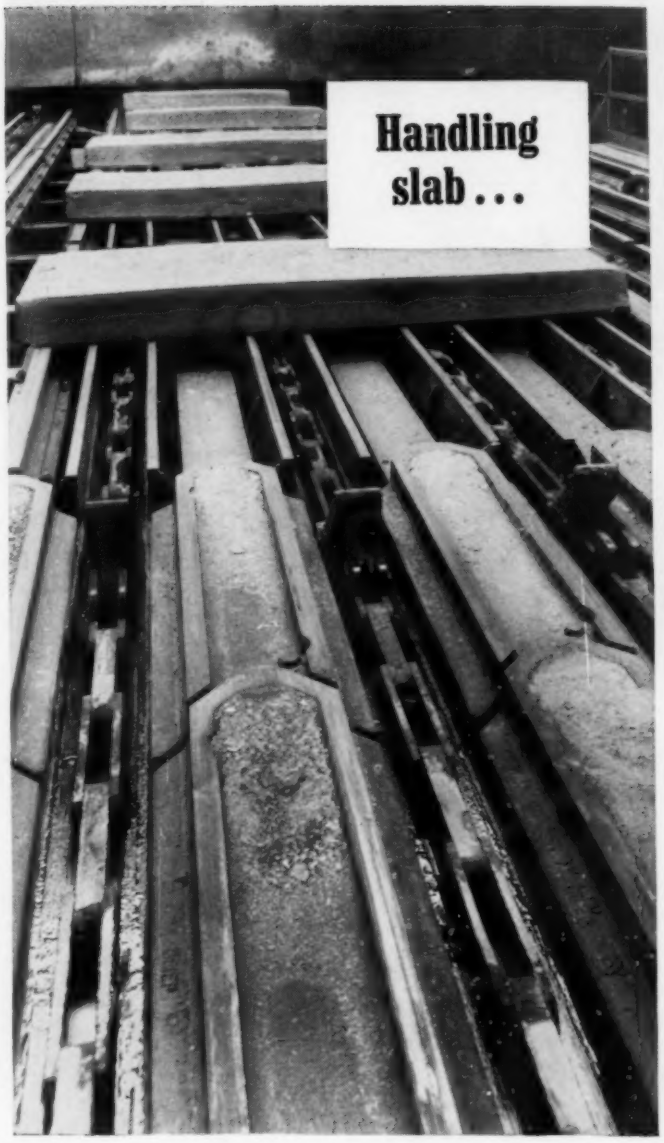
WHEREVER A FURNACE OPERATION IS INVOLVED, Heat Prover can help increase productivity by providing:

1. **Rapid, continuous sampling.**
2. **Simultaneous reading of oxygen and combustibles.**
3. **Direct measurement of oxygen and combustibles.**
4. **Easy portability.**
5. **No maintenance; no re-calibration.**

REMEMBER: Heat Prover is not an instrument you buy but a service we supply. Contact the Cities Service office in your area and learn how Heat Prover can serve you . . . or write CITIES SERVICE OIL COMPANY, Dept. A-17, Sixty Wall Tower, New York City 5.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS



Link-Belt Chains and Sprockets move 8,000 lb. slabs at 60 ft. per min. along a transfer table. Slab temperatures as high as 1800° F are often reached.

At this mill, scrap is handled on a mechanized Link-Belt system. By reducing crane and vehicle movements in the vicinity of crews, safety is improved.

LINK-BELT conveyors help cut costs in steel production . . . every step of the way

IN MILLS all over the country, Link-Belt conveying systems provide important savings in the making of steel. Along every step of the way—from mine to finished product—this fast, safe, economical transportation reduces scrap losses, increases yield.

Slab and scrap handling are but two of the instances in which Link-Belt equipment increases yield and cuts production costs. Link-Belt conveyors offer similar economies for moving coils weighing up to 75,000 lbs. . . . for raw bulk materials, rods, billets, plates, pipe.

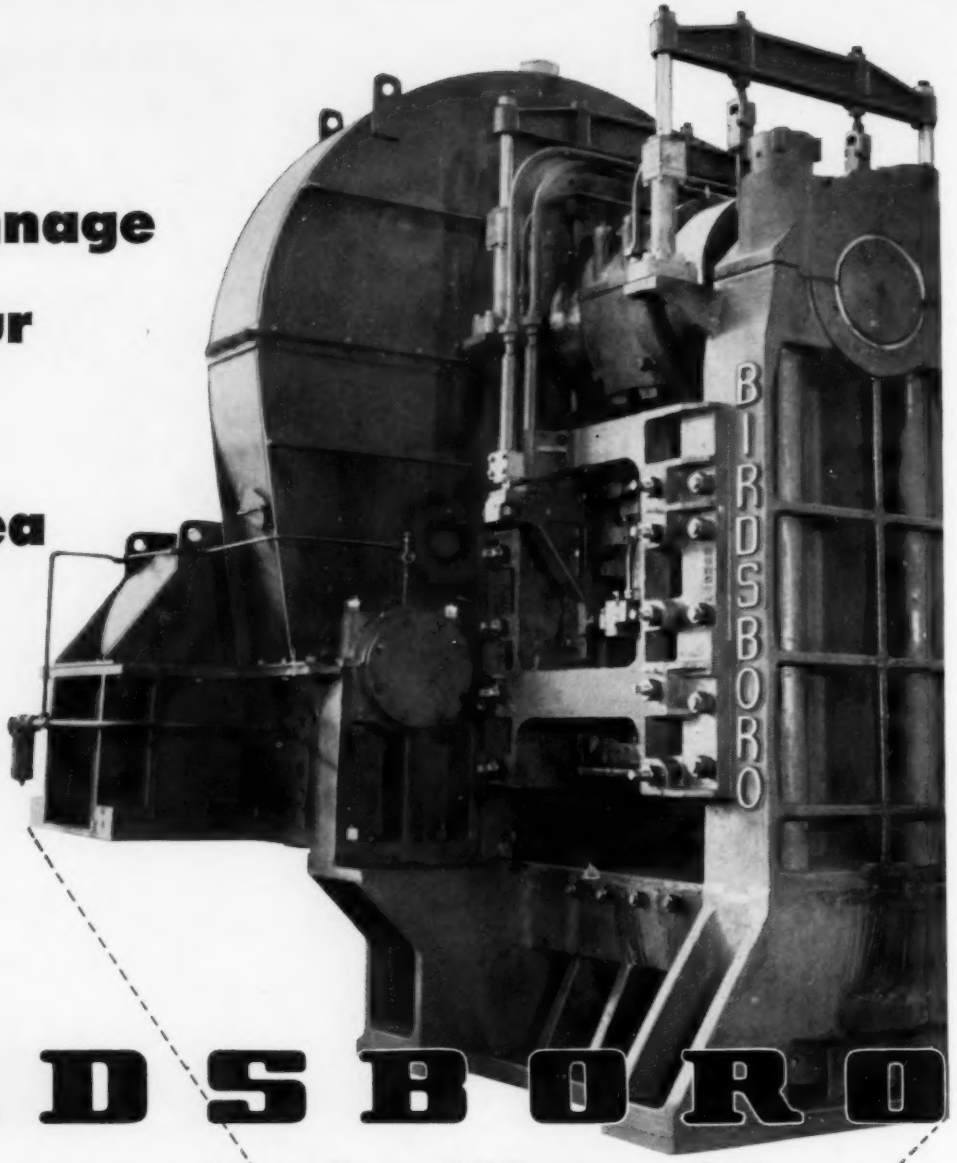
Link-Belt engineers will work with your own engineers, consultants and builders of mill and process equipment. Together, they can give you a conveying system built to your exact requirements.

LINK-BELT

MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa), Sydney (Australia). Offices in Principal Cities. 12,540

For more tonnage from your present work area



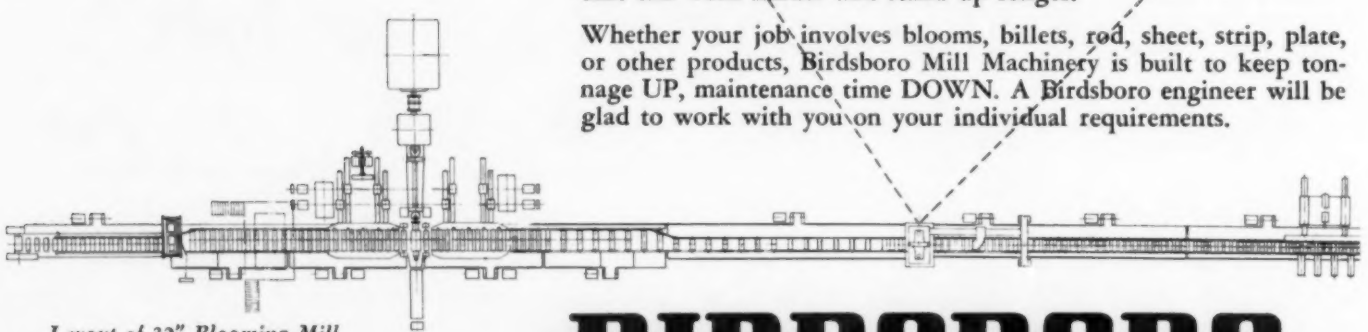
This Birdsboro Bloom and Slab Shear has been designed and built to handle the maximum production of a new 32" Blooming Mill installation.

BIRDSBORO

steel mill machinery

Getting maximum production from every foot of plant space is the demand of the day. And that calls for modern mill machinery that can work harder and stand up longer.

Whether your job involves blooms, billets, rod, sheet, strip, plate, or other products, Birdsboro Mill Machinery is built to keep tonnage UP, maintenance time DOWN. A Birdsboro engineer will be glad to work with you on your individual requirements.



Layout of 32" Blooming Mill

Offices in:
BIRDSBORO, PA.
and
PITTSBURGH, PA.

STEEL MILL MACHINERY

BIRDSBORO
STEEL FOUNDRY & MACHINE CO.
Birdsboro, Penna.

Designers and Builders of:
Steel Mill Machinery • Crushing Machinery • Rolls
Hydraulic Presses • Special Machinery • Steel Castings

MM-24-52-R

Providing the sinews to bite through steel

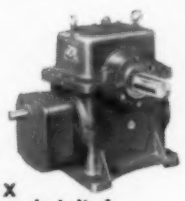
Transmitting power to shear through steel pipe requires a drive of rugged strength. The Foote Bros. Hygrade Worm Gear Drive selected for this service provides the maximum in quality and high efficiency due to advanced engineering — improved design — new techniques in manufacture and better control of material.

Whatever your requirements in enclosed gear drives, you will find one just suited to your needs in the complete Foote Bros. line. A size and type of drive for every need.

Crop End Saw built by The Enterprise Company, Columbus, Ohio, for National Tube Division of United States Steel Company.

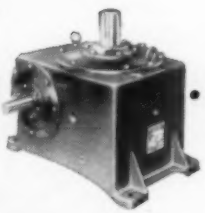
HYGRADE A COMPLETE FAMILY OF ENCLOSED DRIVES

TYPE S
Horizontal right angle worm gear drive. Ratios up to 71 to 1. Cap. up to 266 h.p.



TYPE X
Right angle helical — worm gear drive. Ratios up to 196 to 1. Cap. up to 71 h.p.

TYPE V
Vertical right angle drive, output shaft up, down, or both. Ratios up to 4108 to 1. Cap. up to 216 h.p.



TYPE D
Horizontal double worm gear drive. Ratios up to 4108 to 1. Output torque to 253,000 in. pounds.

TYPE VW
Hytop vertical right angle drive for long, unsupported output shaft extensions. Same ratio and capacity range as TYPE V.

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. IAS, 4545 South Western Boulevard, Chicago 9, Illinois

Please send me Bulletin HGB on FOOTE BROS. Hygrade Worm Gear Drives.

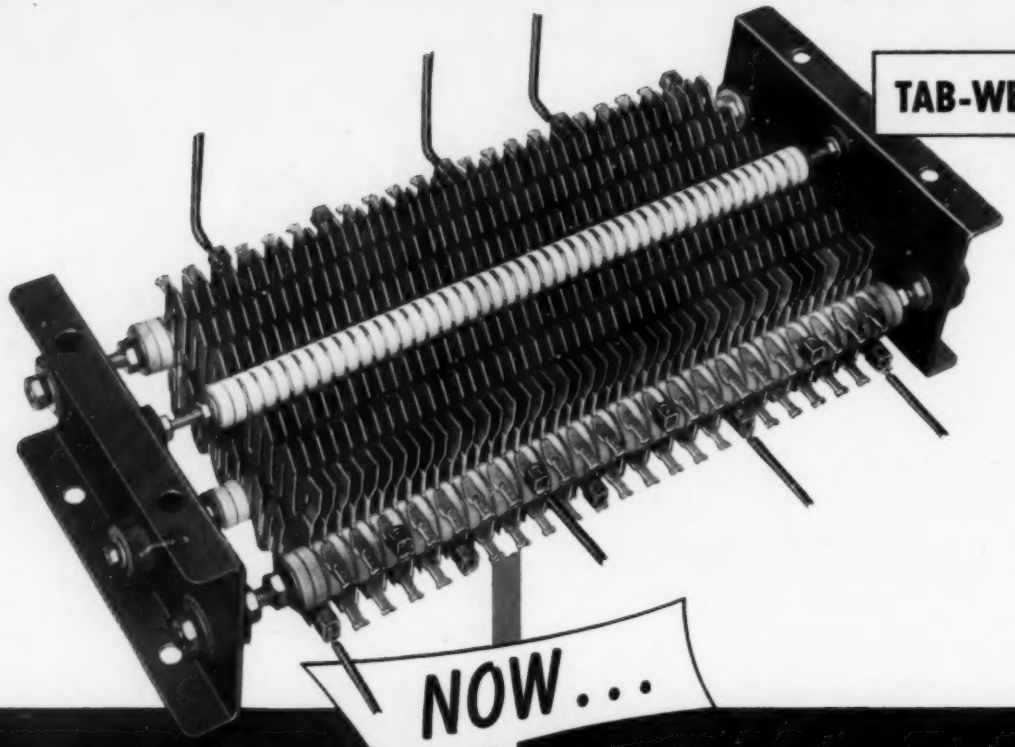
Name.....

Company.....

Position.....

Address.....

City.....Zone.....State.....

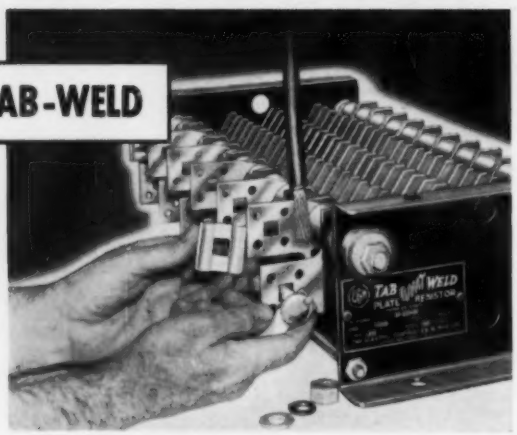


NOW...

A COMPLETE LINE OF

WELDED RESISTOR SECTIONS

up to 150 amperes continuous capacity without internal paralleling



No Crowding . . . 3/8" to 3/4" spacing between grids in EC&M Types TW and TW-X Sections

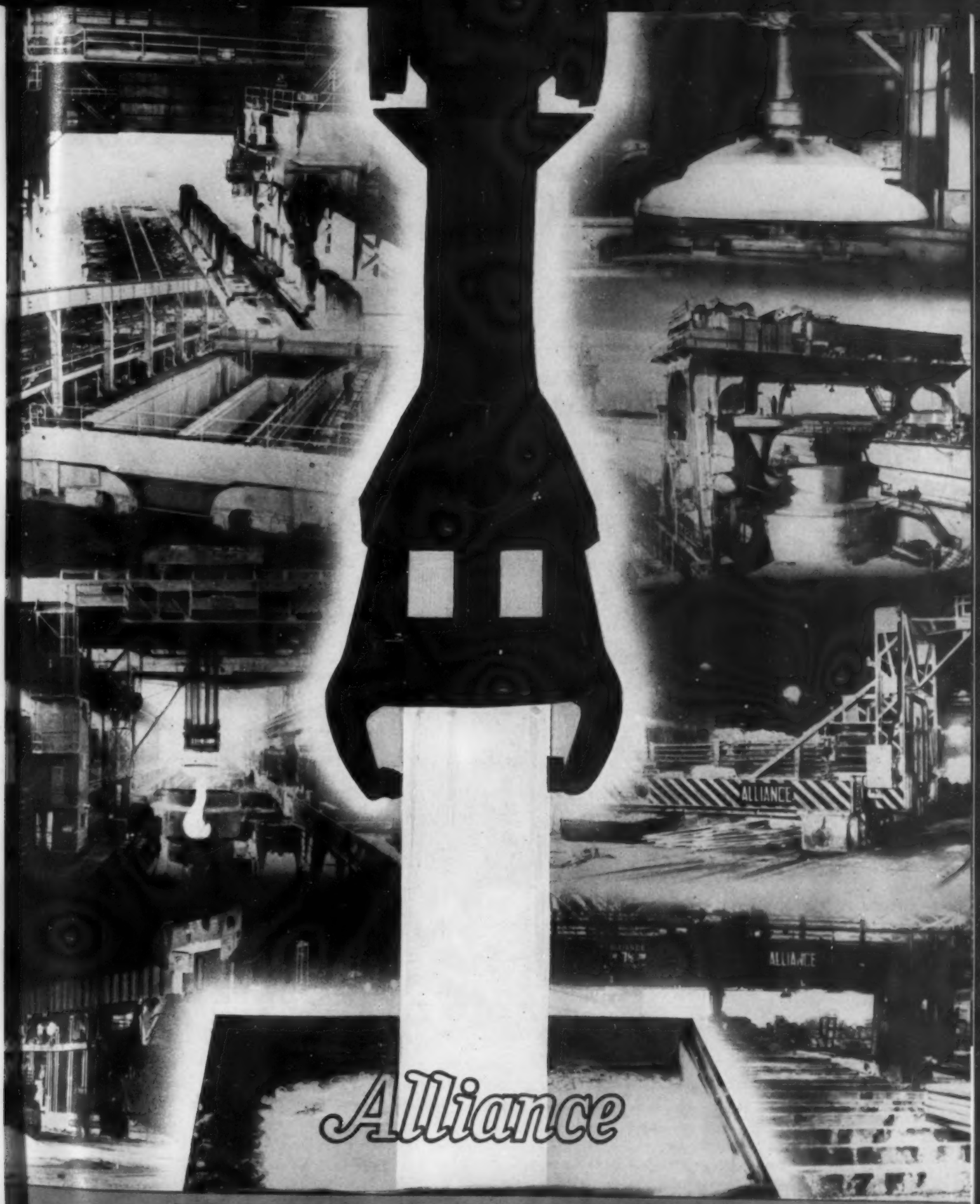
In both styles of EC&M Welded Plate Resistor Sections, heat radiation is *efficient*. Spacing between grids is a minimum of 3/8" on the smallest grid size up to a 3/4" maximum on the 150-ampere continuous capacity section.

Likewise efficiently designed are the individual grids, resulting in completely covering a plant's requirements with a *minimum* of sizes.

Remember, also, these EC&M TAB-WELD Resistors may be used "off-the-storeroom shelf." Many taps make on-the-job connections easy and readily permit small adjustments in resistance-value.

SPECIFY EC&M BULLETIN 942
EC&M TAB-WELD RESISTORS

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO



THE ALLIANCE MACHINE COMPANY

DETROIT PUBLIC LIBRARY

MAIN OFFICE
ALLIANCE, OHIO

PITTSBURGH OFFICE
1622 OLIVER BUILDING, PITTSBURGH, PA.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

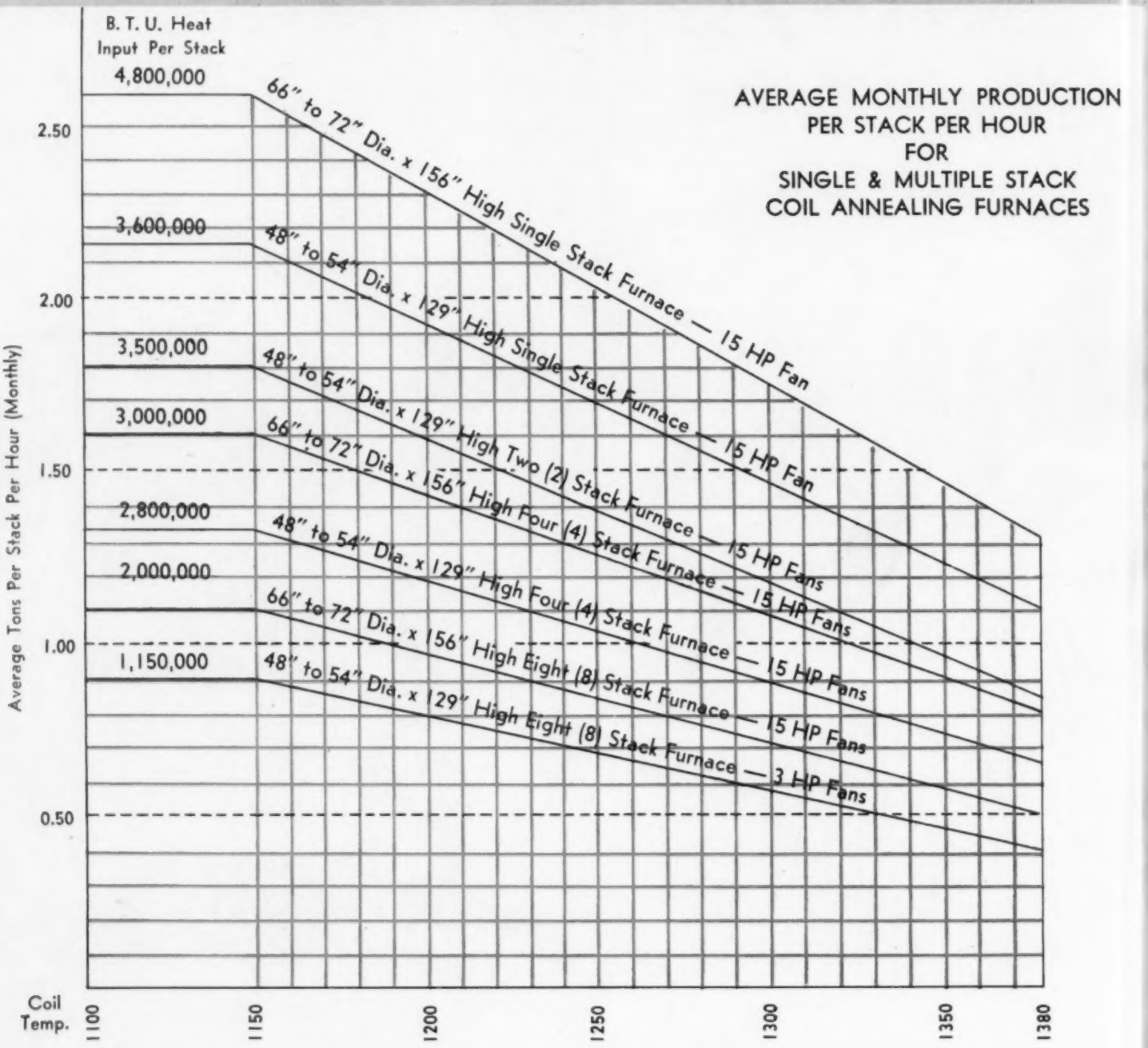
Lee Wilson

ANNEALING FURNACE DATA SHEET

NUMBER EIGHT

REVOLUTIONARY
PORTABLE BASE
SINGLE-STACK
ANNEALING SYSTEM

NEW ANNEALING SYSTEM OUTPRODUCES ALL EXISTING METHOD

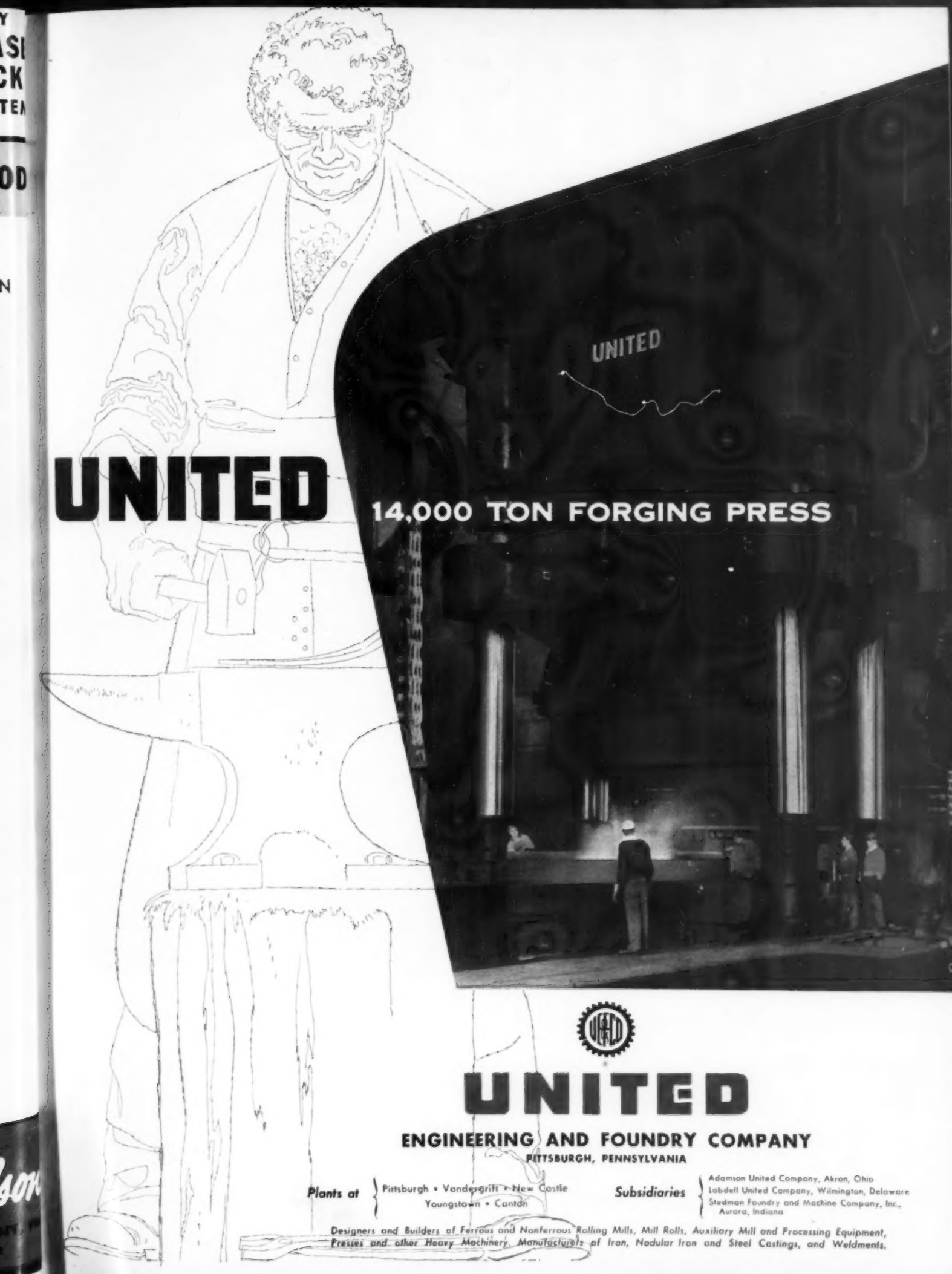

B. T. U. Heat Input Per Stack
4,800,000
3,600,000
3,500,000
3,000,000
2,800,000
2,000,000
1,150,000
AVERAGE MONTHLY PRODUCTION PER STACK PER HOUR FOR SINGLE & MULTIPLE STACK COIL ANNEALING FURNACES
66" to 72" Dia. x 156" High Single Stack Furnace — 15 HP Fan
48" to 54" Dia. x 129" High Single Stack Furnace — 15 HP Fan
48" to 54" Dia. x 129" High Two (2) Stack Furnace — 15 HP Fans
66" to 72" Dia. x 156" High Four (4) Stack Furnace — 15 HP Fans
48" to 54" Dia. x 129" High Four (4) Stack Furnace — 15 HP Fans
66" to 72" Dia. x 156" High Eight (8) Stack Furnace — 15 HP Fans
48" to 54" Dia. x 129" High Eight (8) Stack Furnace — 3 HP Fans
Average Tons Per Stack Per Hour (Monthly)
2.50
2.00
1.50
1.00
0.50
Coil Temp.
1100
1150
1200
1250
1300
1350
1380

The load factor for a single-stack furnace is about 90%, compared with 70% for 4-stack and 60% for 8-stack furnaces. This fact enables the single-stack to produce 50% more tonnage than an 8-stack unit due to load factor alone. Add to this the fact that it is possible to apply twice as much radiation about the bottom of a single-stack furnace and simple arithmetic tells us that this adds an additional 50% production—or a total tonnage increase of 100% over an 8-stand furnace.

Lee Wilson engineers, constantly checking production in the field, find that on an average (using monthly production figures) a multiple-stack furnace will produce about a ton per stand per furnace hour while single-stack units produce about two tons per stand per furnace hour.

the new portable base, should be of great interest to everyone connected with sheet, strip and tin plate coil annealing. For further information, write Lee Wilson for fully explanatory brochure.

Lee Wilson
ENGINEERING COMPANY
CLEVELAND, OHIO



UNITED

ENGINEERING AND FOUNDRY COMPANY

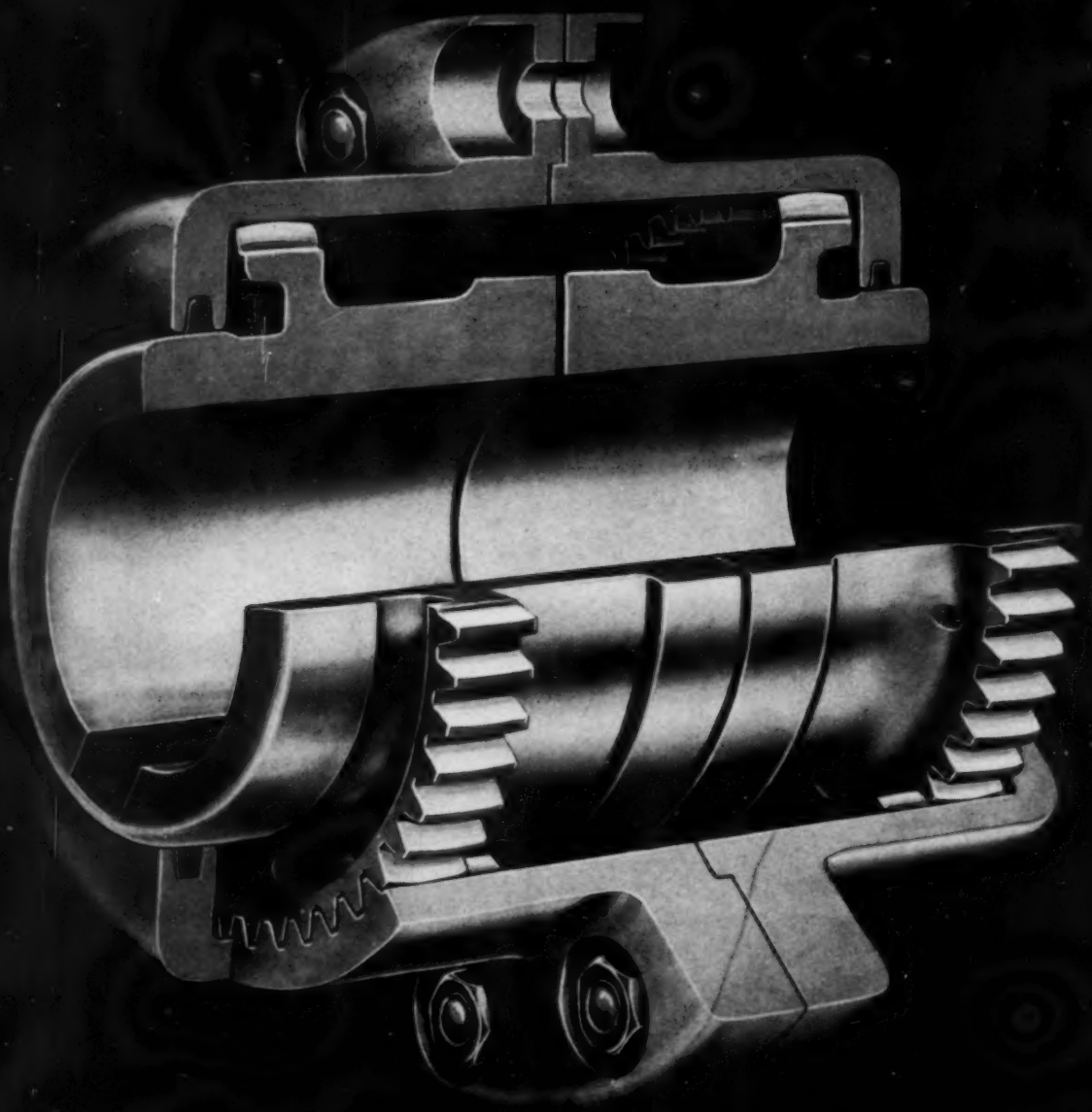
PITTSBURGH, PENNSYLVANIA

Plants at { Pittsburgh • Vandergrift • New Castle
Youngstown • Canton

Subsidiaries { Adamson United Company, Akron, Ohio
Labdell United Company, Wilmington, Delaware
Stedman Foundry and Machine Company, Inc., Aurora, Indiana

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery. Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.

POOLE

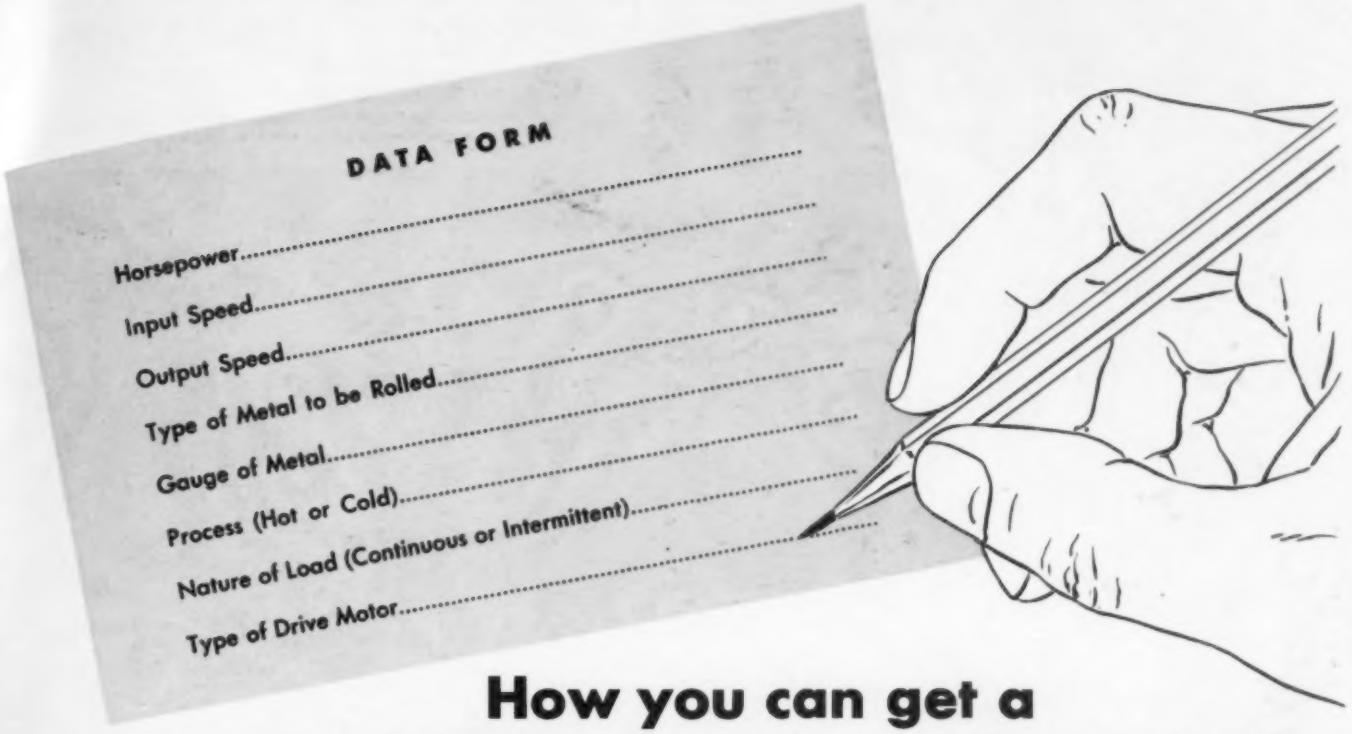


A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD



How you can get a DESIGNED-FOR-THE-JOB MILL DRIVE

Farrel gear drives, pinion stands and combination units are designed and built to suit your needs exactly.

All you have to do is to give us the information outlined in the above data form. We will then do the rest, supplying you with a *designed-for-the-job* unit capable of withstanding the shocks, stresses and wear encountered in continuous, heavy-duty service.

These units are available in any capacity. Their high efficiency and quiet operation are due, to a large extent, to precision generation of gears and pinions by the famous Farrel-Sykes process. This method of generation assures extreme accuracy of tooth spacing, contour and helix angle, which pays off in smooth, uniform power flow.

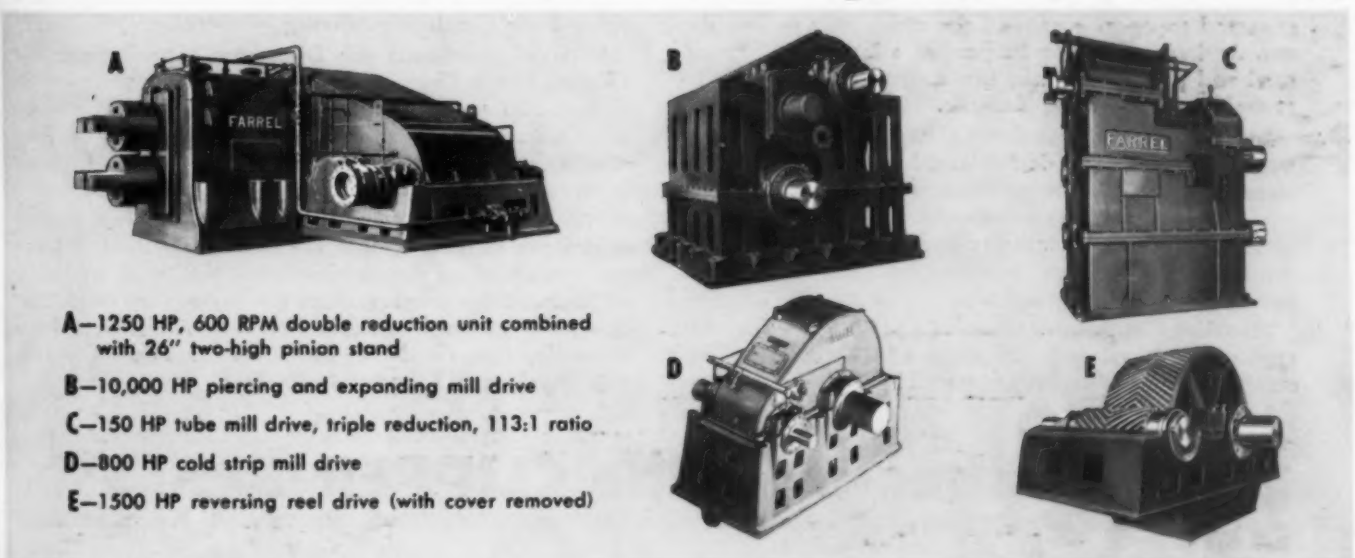
Send for information on reduction gear drives, pinion stands, or combination units for specific applications. Or, if you prefer, our engineers will be glad to discuss gear drive problems with you at any time, without obligation.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston

Farrel-Birmingham®

FB-794



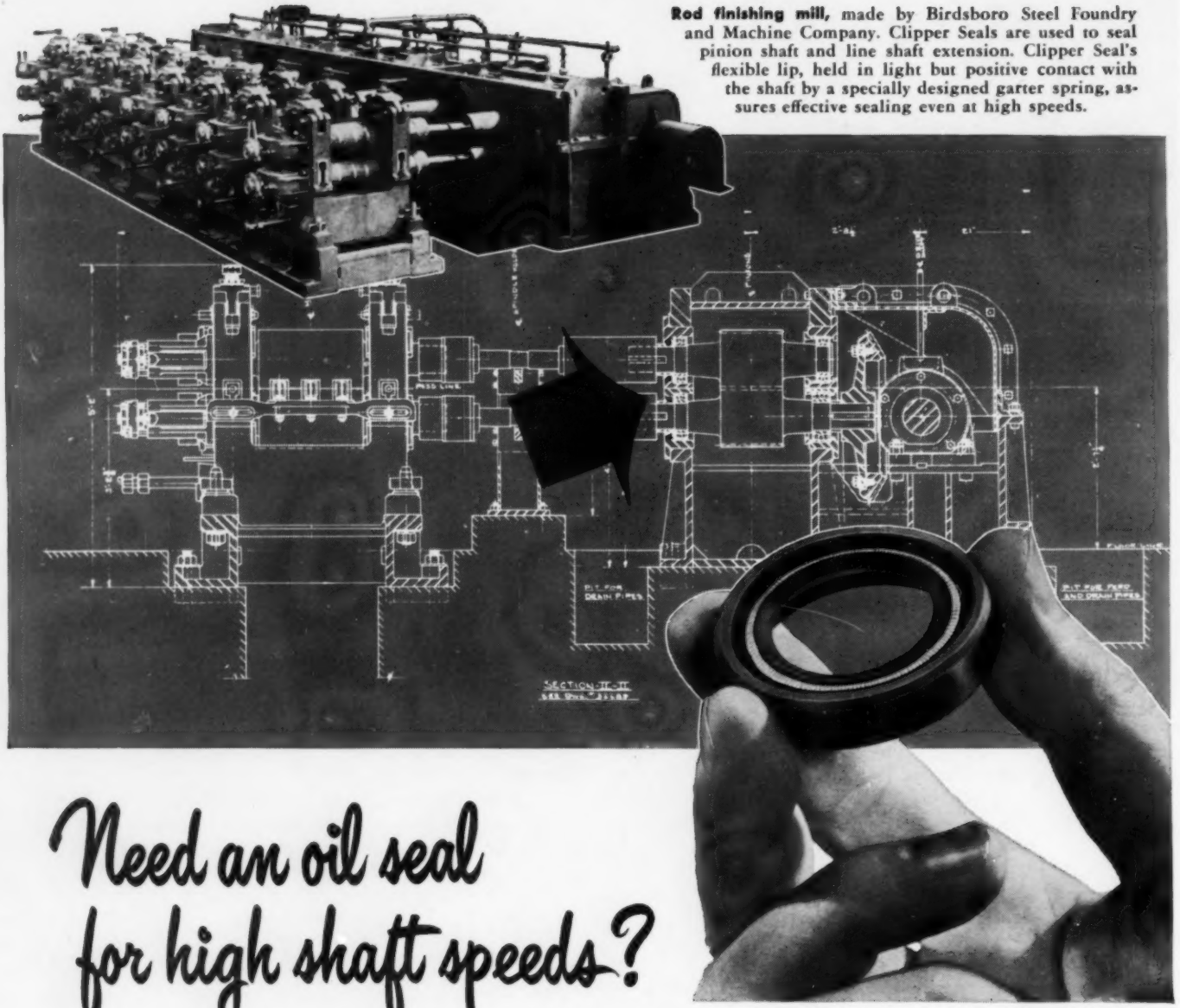
A—1250 HP, 600 RPM double reduction unit combined with 26" two-high pinion stand

B—10,000 HP piercing and expanding mill drive

C—150 HP tube mill drive, triple reduction, 113:1 ratio

D—800 HP cold strip mill drive

E—1500 HP reversing reel drive (with cover removed)



Rod finishing mill, made by Birdsboro Steel Foundry and Machine Company. Clipper Seals are used to seal pinion shaft and line shaft extension. Clipper Seal's flexible lip, held in light but positive contact with the shaft by a specially designed garter spring, assures effective sealing even at high speeds.

Need an oil seal for high shaft speeds?

Birdsboro chose Clipper Seals

The Birdsboro 8-stand finishing train shown above is expected to operate around the clock, day in and day out. And since it is to be part of a large, high-speed, steel rod producing unit, Birdsboro designed it to be as maintenance-free as possible.

In order to minimize down time, particular attention was paid to bearing design and lubrication. The mill stands are equipped with open, water-lubricated bearings. Because of high shaft speeds, bearings in the combination spiral bevel gear reduction and pinion stand are anti-friction in type, lubricated with circulating oil, and sealed with Clipper Seals.

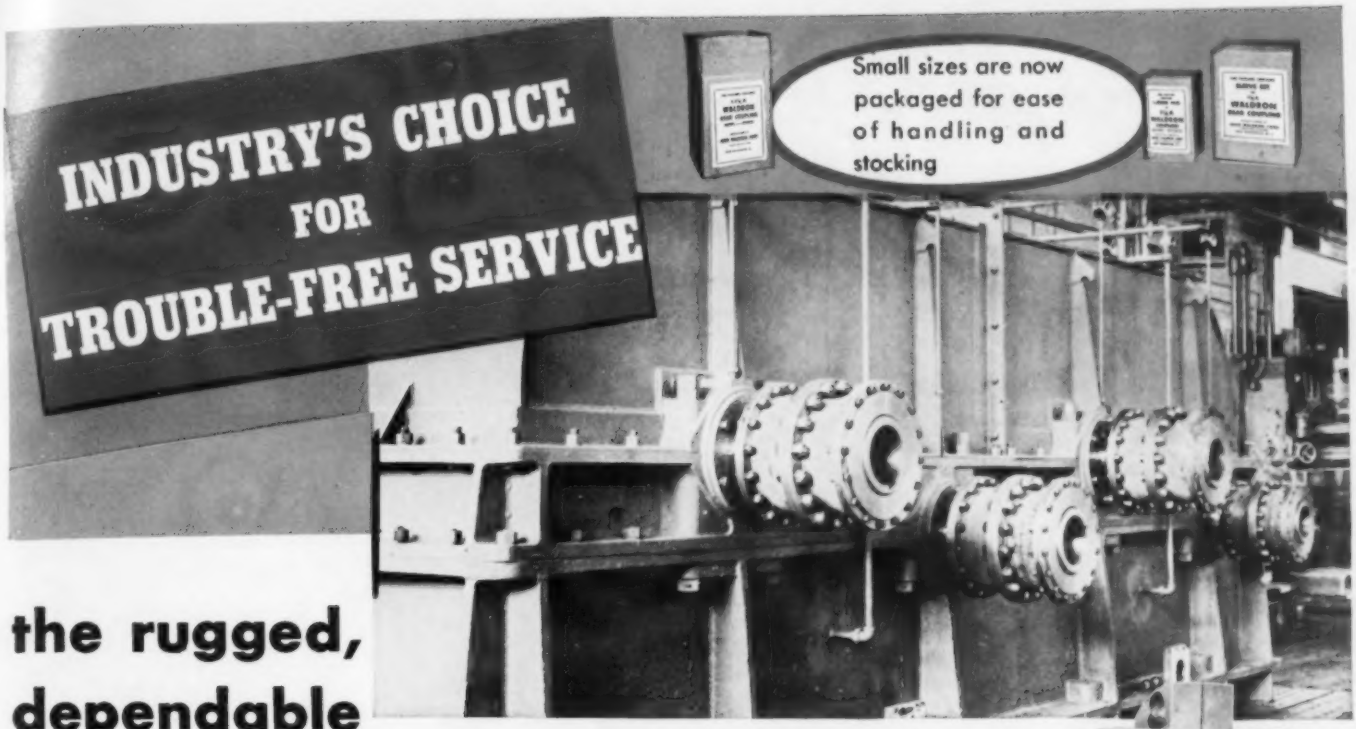
Birdsboro engineers chose Clipper Seals for this application because of their outstanding ability to withstand the heat of friction generated by high shaft speeds . . . and their ability to make a tight and lasting seal against the circulating bearing lubricant.

Still other reasons for Birdsboro's preference for Clipper Seals: They are precision-molded, compact in design, and exceptionally easy to install. They may be removed and replaced without impairing their sealing efficiency. And because of their unique design, Clipper Seals cause a minimum of shaft wear.

Precision-molded Clipper Seals are made in a variety of designs to meet almost any sealing condition. They are available in split and endless types, with a choice of heel and lip combinations for various services. For details, write for Brochure PK-46A. Address, Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

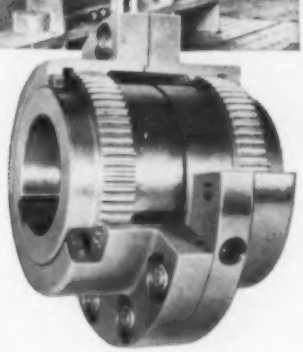


the rugged, dependable

WALDRON

ADVANCED DESIGN

GEAR COUPLINGS



NEW!
WALDRON
Junior
GEAR COUPLING
First light weight, inexpensive coupling of gear type construction for nominal bores—3/8", 1/2", 5/8", 3/4". Made of unbreakable nylon. Weight 2½ ozs. Non-corrosive, non-magnetic. Requires no lubrication. Full particulars on request.

built to eliminate the usual sources of costly coupling failure

The most dependable couplings are those of gear type construction. And throughout industry the WALDRON Gear Coupling is recognized as the most advanced in design and construction of all gear couplings. Its popularity stems from its many design refinements and operating advantages which combine to insure longer service life. Features such as WALDRON all steel construction, one piece cover sleeve, crowned gear teeth, longer lining up surface, automatic lubrication, less rotating weight and others, afford extra protection against costly shutdowns for repairs or replacements. Performance records of WALDRON Gear Couplings over many years have made them first choice of the leading equipment builders. For your gear coupling—specify WALDRON.

Waldron Couplings embody more than 40 years of coupling building experience. Available in all types and sizes. Design easily adapted for special applications. Write for descriptive catalog and specific engineering data.

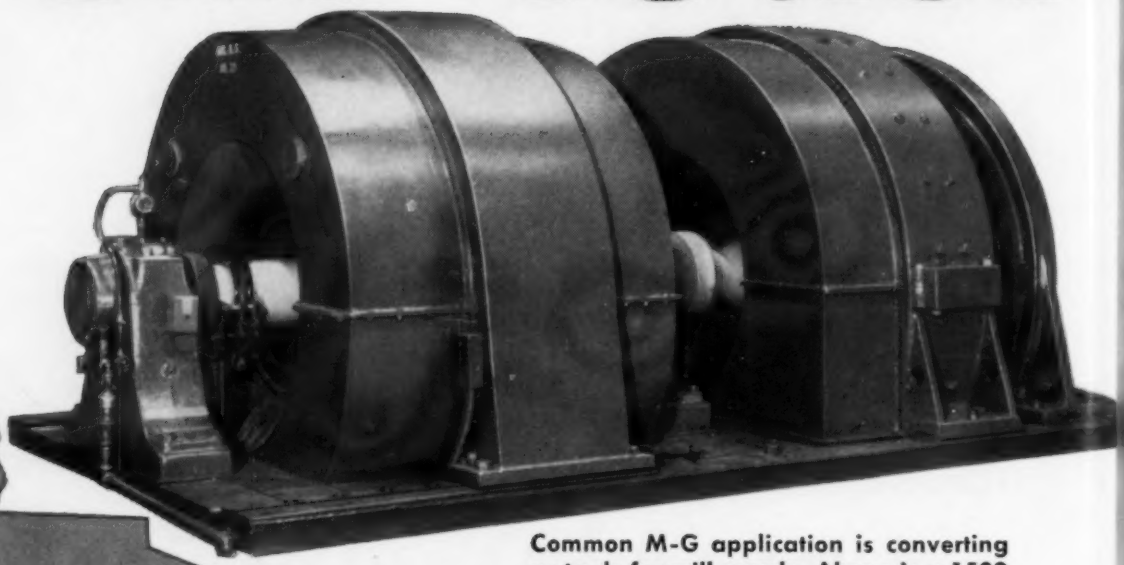
JOHN WALDRON CORPORATION

Waldron Series "A" and Junior Gear Couplings Francke Pin Type Coupling Anchor-Waldron Overload Cut-Outs

NEW BRUNSWICK • NEW JERSEY

Sales Representatives In Principal Cities • In Canada—Peacock Brothers, Ltd.

From Coast



Common M-G application is converting ac to dc for mill supply. Above is a 1500 kw synchronous set in eastern mill.

WEST

This 8-machine 2000 kw M-G set supports a two stand, four high tin temper mill with generators opposite their mill motors.

MIDWEST

A 56-inch, four stand tandem cold reduction mill is supported by this 7-machine 7750 kw synchronous motor-generator set.

EAST

Three 3-machine 6000 kw synchronous M-G sets supporting six finishing stand motors in a large East Coast steel rolling mill.

TEMPER MILL

Three midwestern single stand temper mills are supported by these M-G sets. Synchronous motors of 1750 hp drive each set.

to Coast!

ALLIS-CHALMERS M-G SETS ARE WIDELY USED IN SUPPORT OF STEEL MILL DC DRIVES

MAJOR STEEL PRODUCERS from Coast to Coast use Allis-Chalmers motor-generator sets. This nationwide acceptance in heavy duty service is proof of their durability and quality.

These representative M-G sets indicate the wide variety in design and size available. Allis-Chalmers has long experience with steel mill needs — having built M-G sets for all current applications — and will build special for any new requirement that may arise.

Motor-generator sets give you:

1. Power factor correction.
2. Regenerative braking.
3. Quick starting for emergency demand.

Only Allis-Chalmers gives you M-G sets with the exclusive *Frog-Leg* armature winding that ***eliminates injurious commutator sparking.*** *Frog-Leg* winding connects bars of equal potential through the winding itself . . . producing a perfectly equalized winding without the use of cross-connectors.

For full details on this heavy duty steel mill rotating equipment, ask for M-G Set Bulletin 05B6032A and Large DC Motor Bulletin 05B6002A. For your copies, just call the nearest A-C office or write direct to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3920

Frog-Leg is an Allis-Chalmers trademark.

PICKLING LINE

A pickling line in an eastern steel mill is supported by this 4-machine 1375 kw, 720 rpm synchronous M-G set.

RECORD BREAKER

A motor room, completely equipped by Allis-Chalmers, powered this 80-inch western hot strip mill to a new annual world tonnage record.

ALLIS-CHALMERS

Power, Electrical, Processing Equipment for Iron and Steel

A-C ALLIS-CHALMERS

TIMKEN® work roll bearings on plate mill go 16 years without replacement!

THE same Timken® bearings are still going strong—*after 16 years' operation* — on the work rolls of a United 36″ x 54″ x 120″ reversing mill in regular service in an Eastern plant of a large steel producer. In all that time, not a single bearing replacement has been made on the work rolls.

The mill's back-up rolls, screw down, and mill main drive are also mounted on Timken tapered roller bearings. With Timken bearings, long, trouble-free service is assured. Time-outs for maintenance and repair are held to a minimum.

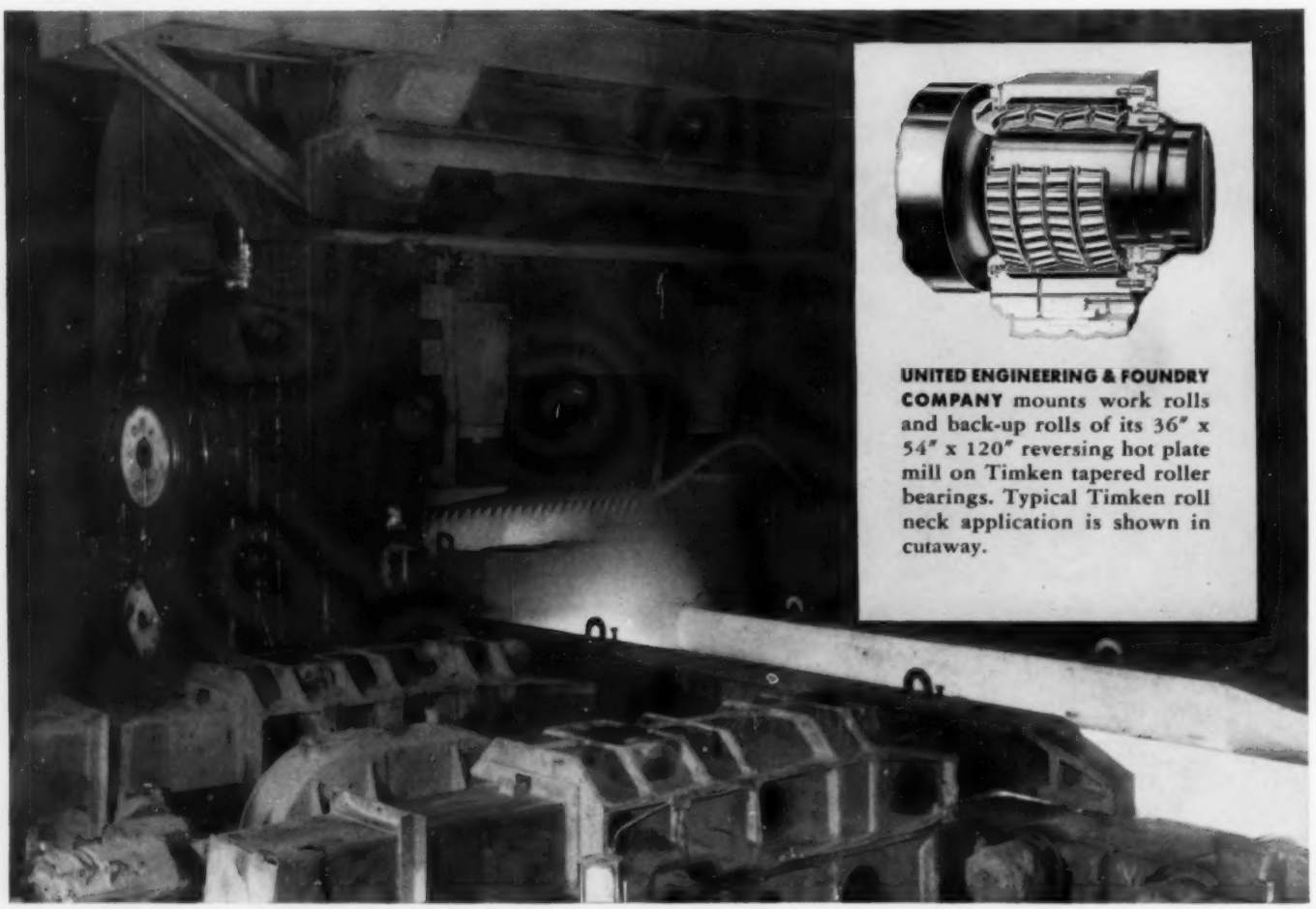
Timken bearings on work rolls and back-up rolls eliminate costly and complicated lubrication systems. Rolls can be quickly and easily changed. Simple, economical grease lubrication is used.

Since Timken bearings take both radial and thrust loads in any combination, special thrust bearings are not needed. Chuck mountings are simpler, more compact. Weight is minimized.

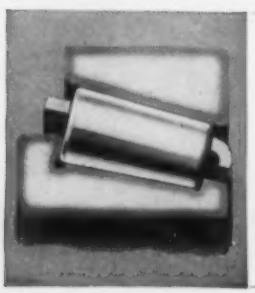
Because of their true rolling motion and incredibly smooth surface finish, Timken bearings have a lower starting resistance. Mills can accelerate more rapidly.

Years of Timken bearing research and development have resulted in many improvements in roll neck bearing design and performance. Write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



UNITED ENGINEERING & FOUNDRY COMPANY mounts work rolls and back-up rolls of its 36″ x 54″ x 120″ reversing hot plate mill on Timken tapered roller bearings. Typical Timken roll neck application is shown in cutaway.



GREATER LOAD AREA

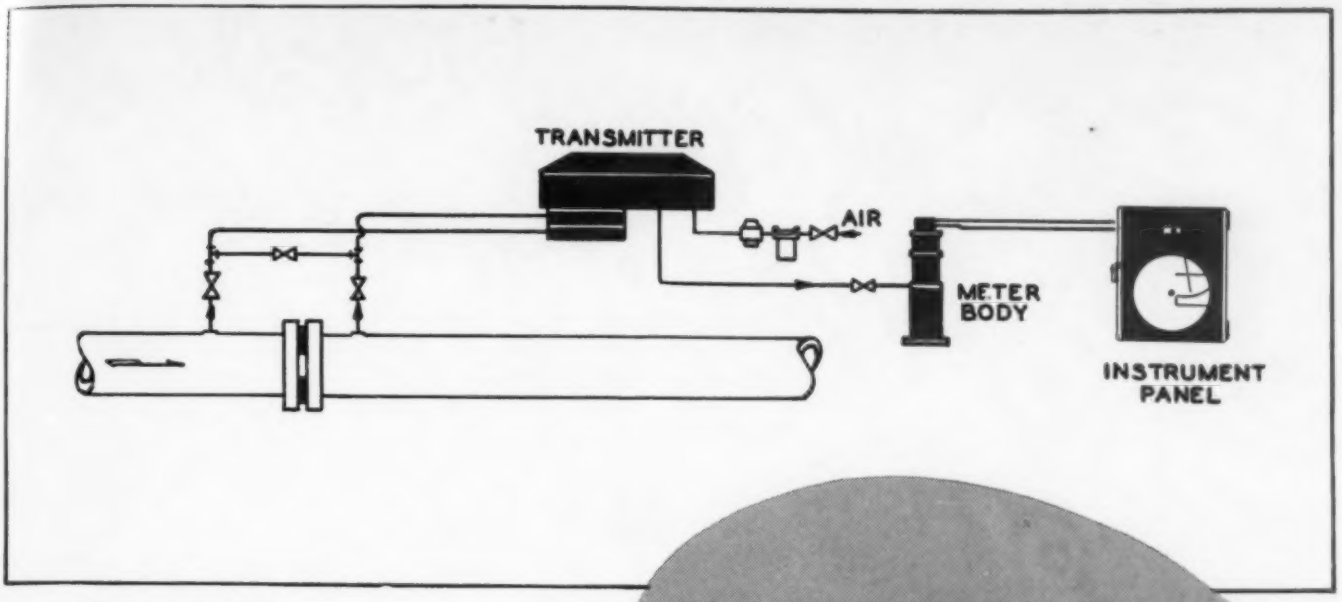
Because the load is carried on the *line* of contact between rollers and races, Timken bearings carry greater loads, hold shafts in line, wear longer.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



Republic Pneumatic Electric Metering System

DESIGNED ESPECIALLY for YOU Mr. Steelmaker to Measure Blast Furnace and Coke Oven Gas Flow

We had your problems in mind when we designed the Pneumatic Electric Flow Meter. We know a steel mill is a dusty place; it can't be otherwise and do a good job making steel. We know the gases produced in a steel mill are dirty. So, to help you steel mill people keep track of what is going on inside your maze of pipes, furnaces and ovens, we designed a meter that could operate in dusty surroundings and accurately measure flow of dirty gases without frequent maintenance. Yes, we engineered the dirt right out of the meter.

Here's How:

KEEPS DIRT OUT

The Pneumatic Electric Flow Meter uses a differential pressure transmitter to isolate dirty gases from direct contact with mercury in meter body. Transmitter establishes an air loading pressure that is directly proportional to flow differential. The measuring chamber of the transmitter is small and has practically no change in volume when differential pressure changes. Thus, dirt in the gas is not sucked into the chamber to cause the diaphragm to stick or clog.

DOUBLY DUST SEALED

Rugged boiler meter case completely encloses reading instruments which are individually sealed. Double seal prevents dirt from getting in to foul or clog parts and cause inaccuracies or failure.

REMOTE READING INSTRUMENTS

Meter body responds to air loading pressure changes from transmitter and produces proportional electrical variations which are transferred to remote reading instruments. Integrator and recorder operate independently — may be separated to suit individual requirements.

OVER-ALL ACCURACY

Differential pressure transmitter is extremely sensitive to pressure changes, however rapid. Mercury in meter body has no work to do, only makes or breaks contact with resistance rods. Recorder permanently records rate of flow and time of flow changes. Integrator working on modified watt-hour principle *continuously* totalizes all flow, not just average of spot readings. Accurately follows all sudden changes in flow.

RANGE EASILY CHANGED

Differential pressure transmitter and meter body can be adjusted (many times right in the field) for almost any range.

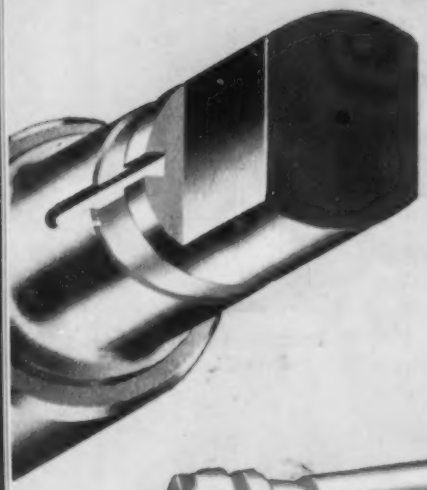
CONTINUOUS METERING

Measurement and control of fluid flow is not interrupted by meter failure because Pneumatic Electric Flow Meter is built to give dependable, maintenance-free service. Working mechanism is accessible and easy to adjust. And remember—Republic has 28 branch offices throughout the country, so there's one near you to help you with your metering and control service problems.

Pneumatic Electric Flow Meter is also excellent for metering widely varying flows such as occur in oxygen scarfing operations.

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois



PHOENIXLOY ROLLS are color marked for specific uses in rolling . . .

WORK ROLLS FOR 2 AND 4 HIGH COLD MILLS

PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION of BLAW-KNOX COMPANY • PITTSBURGH, PA.

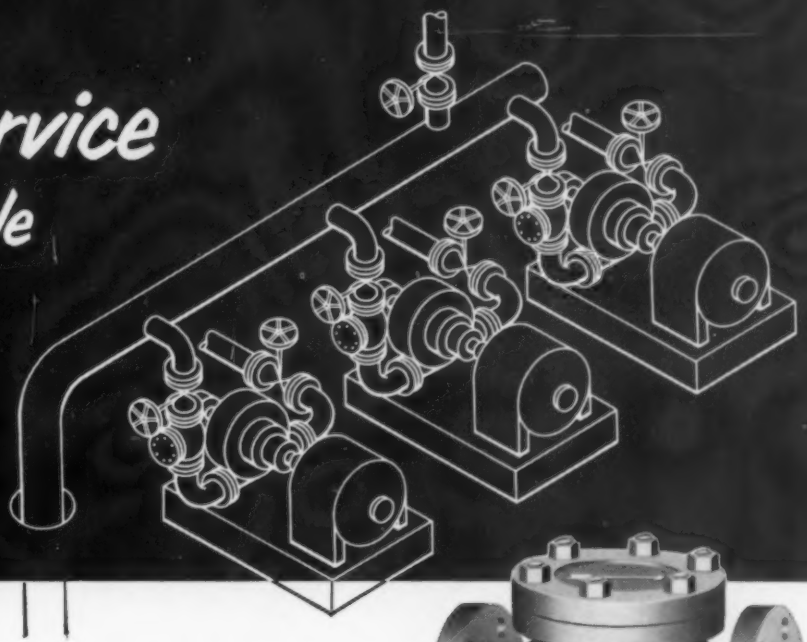
OTHER PITTSBURGH ROLL TYPES

- Chill
- Moly Chill
- Special Rail Finishing
- Phoenix "K"
- Pittsburgh Grade 25
- Pittsburgh Grade 35
- Pittsburgh Grade 45
- Pittsburgh Grade 55
- Pittsburgh Grade Special Process
- Phoenix Metal
- Phoenix Metal Master
- Phoenix "A" Alloy Steel
- Phoenix "A" Special Alloy Steel
- Carbon Steel

It's not what you Pay for Valves ...it's what they Cost you

on Water Service for example

(A Case History)



What you pay for valves is not the final criterion of value. Not when maintenance costs can quickly equal or exceed purchase price. And a valve that threatens production is no bargain at any price . . . no attraction to a thrifty buyer.

Take this case in a large eastern paper mill. A single bank of water pumps supplied the entire mill. Leaky check valves at these pumps were a constant problem. Regularly, the checks needed replacement, only to be found leaking between pumping cycles a few months later.

A change-over to Crane Quality Check Valves put a complete stop to this costly maintenance and threat to production. Installed well over a year, Crane checks are protecting the mill against loss of water pressure at no added cost.

Today, more than ever, you need greater assurance of quality in piping materials. You get it in Crane Valves—the recognized standard of quality with thrifty buyers in every industry. Your big Crane Catalog offers complete selections for all needs; your Crane Representative is always at your service.

Crane Check Valves are made in all types, in brass, iron, steel, and alloys. See your Crane Catalog.

CRANE VALVES

Crane Co., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas.

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

2 new BLISS mills

and do it better at Chase...

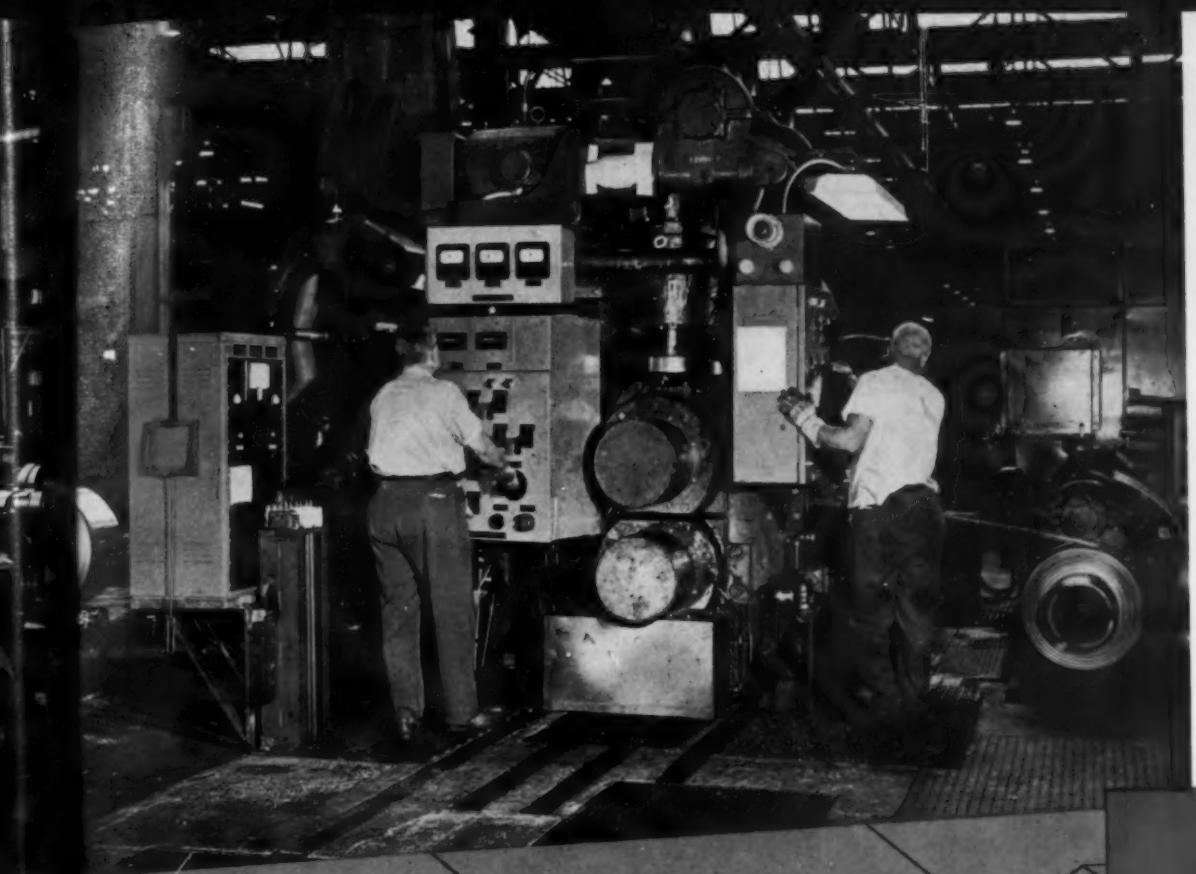
Higher production...closer tolerances...*less equipment*...all these are now a reality at the Chase Metal Works plant of Chase Brass & Copper Co., subsidiary of Kennecott Copper Corporation.

Chase wanted mills that would take a 50% reduction on brass strip at 500 fpm; and auxiliary equipment to handle coils weighing 200 lbs. per inch of width.

Bliss designed and built a pair of two-high mills, one 16″ x 16″ and the other 20″ x 22″, to suit various widths. Now quality and quantity of output from the new Bliss mills exceed that of the *five* old mills.

The Bliss mills run up to 1000 fpm and easily hold tolerances to 0.0005″; and these speeds offer quite an advantage on finish passes.

The 50% reduction made on Bliss mills is *twice* the amount possible on the old equipment. The Bliss units, with capacity of 200 lbs. per inch of width, handle 2400-lb. coils (for 12″ strip) on the



5 do the work of

16″ mill, and 3600-lb. coils (for 18″ strip) on the 20″ mill.

Bliss engineers sought carefully to include in the designs the desired characteristics of a mill suitable for reduction and finish rolling. The planished surface obtained is so good that further buffing is unnecessary.

If you have a rolling mill production problem, you'll find as Chase did—that it pays to call in Bliss. Take the first step toward increased production: write for your copy of the 52-page brochure, "Rolling Mills and Accessories," Bulletin 40.

E. W. BLISS COMPANY · General Office: Canton, Ohio
ROLLING MILL DIVISION: SALEM, OHIO
E. W. Bliss (England) Ltd., Derby, England
E. W. Bliss Company (Paris), St. Ouen sur Seine, France

Branch offices in Chicago, Cleveland, Dayton, Detroit, Indianapolis, New Haven, New York, Philadelphia, Rochester, Toledo; and Toronto, Canada. West Coast Representatives: Moore Machinery Company, Los Angeles and San Francisco; Star Machinery Company, Seattle.
Other dealers in United States cities and throughout the world.

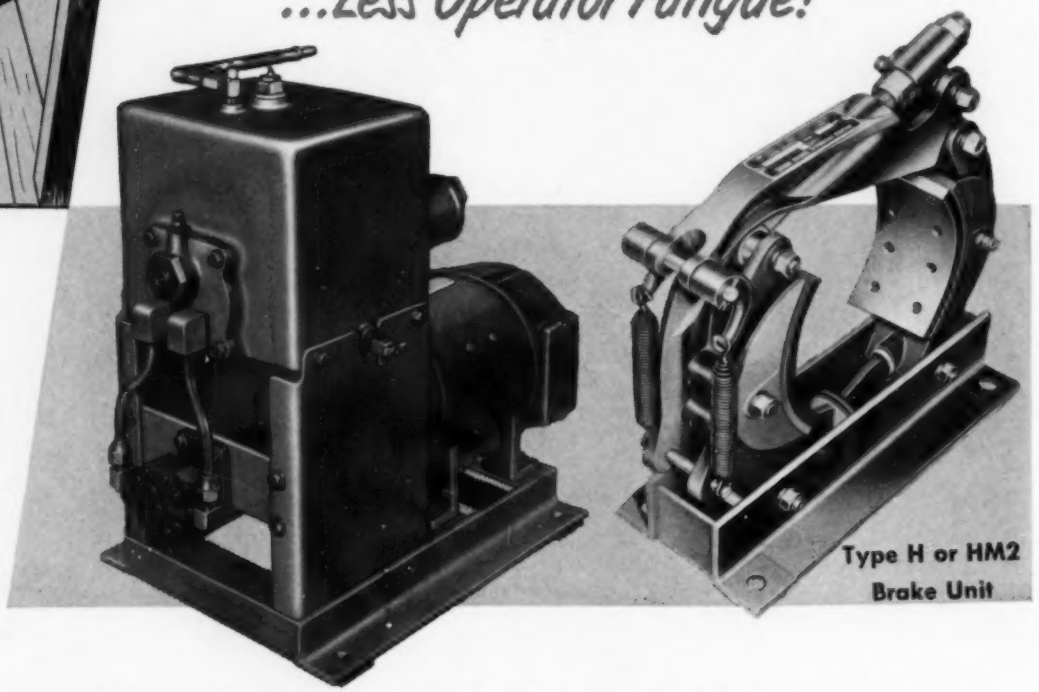
Remember: **for Presses, ROLLING MILLS and Special Machinery...**

It's Bliss

Now... Wagner Powered Hydraulic Crane Bridge Braking

for safer, more efficient Crane operation

...More Torque ...Greater Capacity ...Less Operator Fatigue!



Hydraulic power unit driven by totally-enclosed motor

Type H or HM2 Brake Unit

These new *Powered* Hydraulic Crane Bridge Brakes mean that your operators can bring even the largest crane to a safe, smooth stop at the touch of a toe. Loads can be spotted accurately—production can be stepped up—several brakes can be operated from one pedal—*all with less operator fatigue!*

Wagner Powered Hydraulic Braking Systems are designed for applications where frequent starts and stops are necessary . . . where close spotting is used . . . where large heavy equipment is involved . . . and for applications where exceptional ease of brake operation is desired.

Wagner Powered Braking Systems mean longer life for your equipment . . . Operators have less tendency to drag brakes and thus wear out wheels and lining quickly—cranes can be controlled without plugging the bridge motor with resultant damage to the motor and gears.

Wagner powered units can be added to your present Wagner Hydraulic Bridge Brake System. Investigate this new method of braking today—write for Bulletin IU-36 which fully explains and describes Wagner Powered Hydraulic Braking.

Replacement Lining and Brake Wheels

Wagner offers the perfect combination of brake wheel and non-scoring lining for replacement needs. Wagner Brake Lining is specially designed and manufactured to meet the exacting service requirements of industrial braking. It is available in rolls, blocks, and discs.

WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

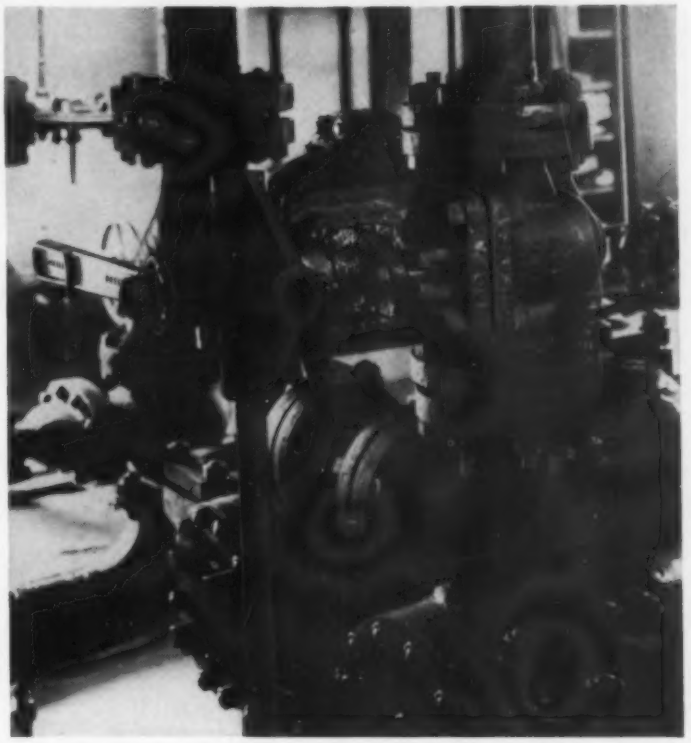
BRANCHES IN 32 PRINCIPAL CITIES

152-3

Four years maintenance-free service on Propane at 300 pounds pressure—temperatures from 60° F. above to 40° F. below zero . . .

. . . THAT KIND OF PERFORMANCE IS AN "OLD STORY" WITH . . .

HOMESTEAD *Lever-Seald* VALVES



Propane at 300 lbs. pressure, minus 40° F.

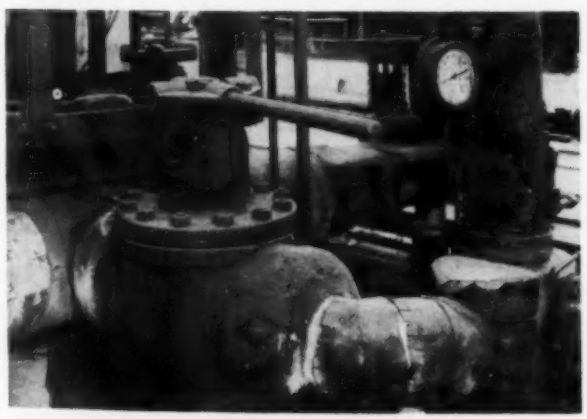
A prominent Mid-Western Oil Refiner* installed a 3", flanged, cast-steel, straightway HOMESTEAD Lever-Seald VALVE on Propane service at 300 lbs. working pressure with a temperature range from 60° F. above to 40° F. below zero. After four years service, with no maintenance except repacking, the valve still held tight.

That sold him—proved to him that HOMESTEAD Lever-Seald VALVES are his "best buy!" Today he is using Lever-Sealds on Propane and on drag lines from stills, another difficult service.

HOMESTEAD Lever-Seald VALVES really lick tough problems, not only in the Processing Industries, but in scores of other industries as well. And wise buyers know that savings effected on difficult services are made in even greater degree on "every day" air, steam, water, gas and oil jobs.

Why don't *you* prove to *your own* satisfaction that HOMESTEAD Lever-Seald VALVES are *your* "best buy," by putting some to work in your plant?

**Name on request.*



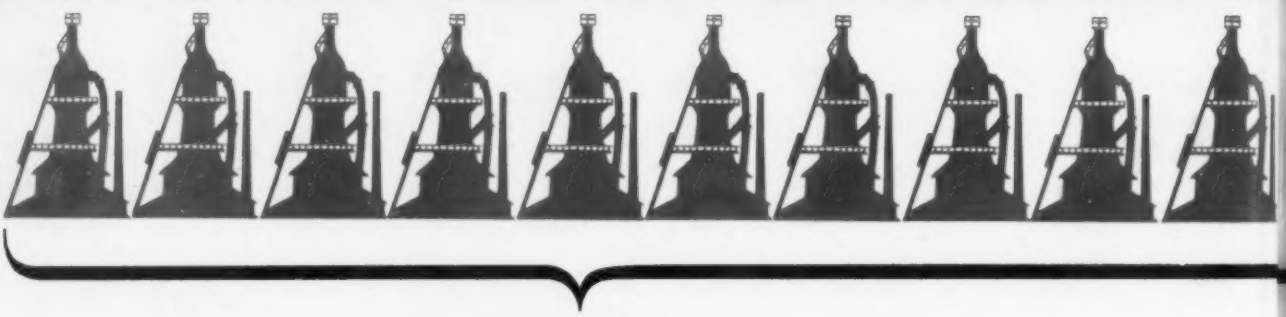
Drag line from still handling oil and tar at 800° F., 100 lbs. pressure.

For complete technical data and prices, WRITE FOR "VALVE REFERENCE BOOK No. 39." No obligation.

HOMESTEAD
VALVE MANUFACTURING CO.

P. O. BOX 21 — *"Serving Since 1892"* — CORAOPOLIS, PA.

of the 19 most recently HARBISON-WALKER Refractories



HARBISON-WALKER

HARBISON-WALKER BLAST FURNACE REFRACTORIES

BENEZET BF and HW Ky. BF—for many years, the standard refractories for most blast furnaces—for hearth and bosh, inwall and top linings. Harbison-Walker's research program has continued to improve these standard quality products as well as to lead in the development of the super-duty classes.

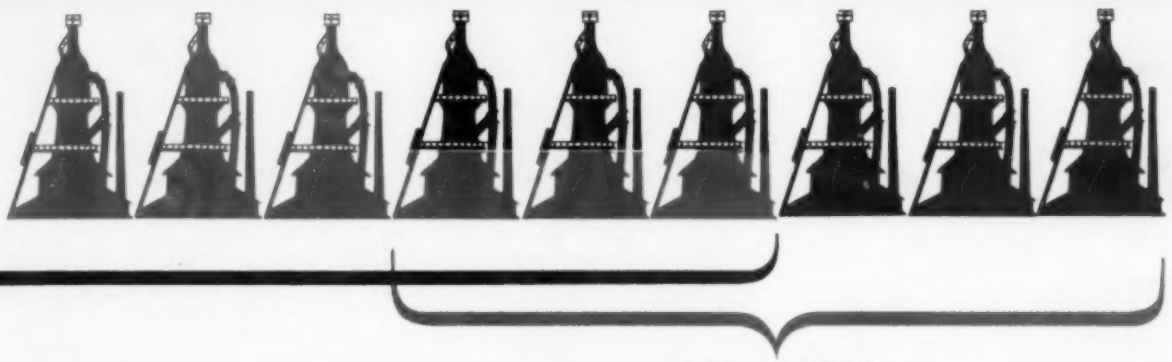
H-W 18 Pa. and H-W 18 Ky.—hard burned, high duty fireclay brick. Exceptionally resistant to abrasion, and to disintegration by carbon monoxide. H-W 18 brick are low in permeability and porosity, have high mechanical strength and excellent volume stability at working temperatures.

VARNON BF—extremely hard-fired, super-duty fireclay brick, having high strength and density, low porosity and permeability, immunity to disintegration by carbon monoxide, high refractoriness and resistance to slagging.

BONDING MORTARS—Harbison-Walker produces Bonding Mortars especially suited for every blast furnace need. Included in these are the highly plastic HW BOND B and HW IMMUNITE hot-set mortars and HARWACO BOND cold-set cement. The best results are secured with the proper selection of these mortars according to the service requirement.

completed Blast Furnaces

are used in 16 !



Outstanding preference for Harbison-Walker Blast Furnace and Stove Refractories is expressed in *orders* by the companies who produce the bulk of the nation's iron. Their choice is based upon long experience with Harbison-Walker products.

During the recent expansion of iron-making facilities, nineteen new blast furnaces have been built or are now nearing completion. In all but three of these, Harbison-Walker refractories are used!

Through continuous research and engineering development, Harbison-Walker has provided new and improved refractories to meet the iron and steel maker's increasing demands, and today, Harbison-Walker brands include the types and classes that will serve *best* for every requirement.

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
World's Largest Producer of Refractories
General Offices: Pittsburgh 22, Pa.

Any way you look at it...

SQUARE D's balanced design means a better Motor Starter

Designed to provide the highest degree of accessibility, flexibility, and compactness —with no sacrifice of performance and long life.

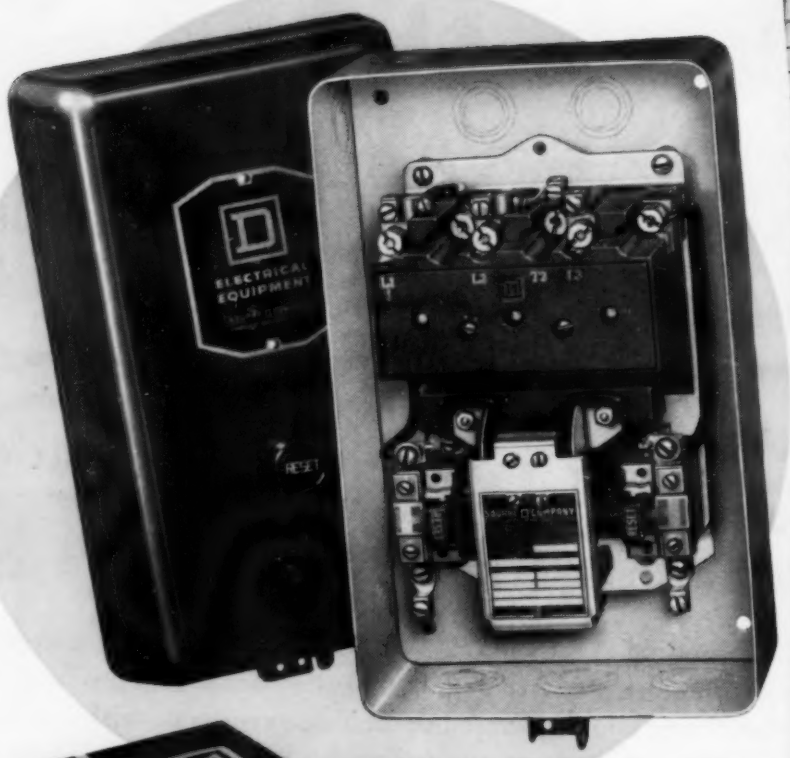
EASY WIRING...
Plenty of wiring space and easy-to-get-at solderless terminals. Installation is a breeze.

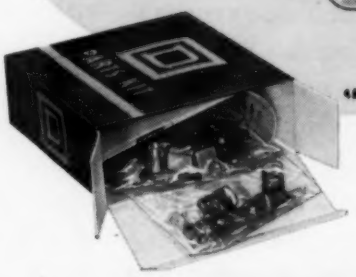
ACCESSIBILITY...
Coils, contacts or overload relays can be changed without disturbing external connections. A screwdriver is the only tool you need.

FLEXIBILITY...
Three extra electrical interlocks may be added to size 1 starters; four to sizes 2 and 3. Contacts may be normally open, normally closed, or double circuit.

PERFORMANCE...
Straight line, guided motion minimizes wear. Large silver alloy contacts insure exceptionally long life and trouble-free performance.

Write for Bulletin 8536
Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin



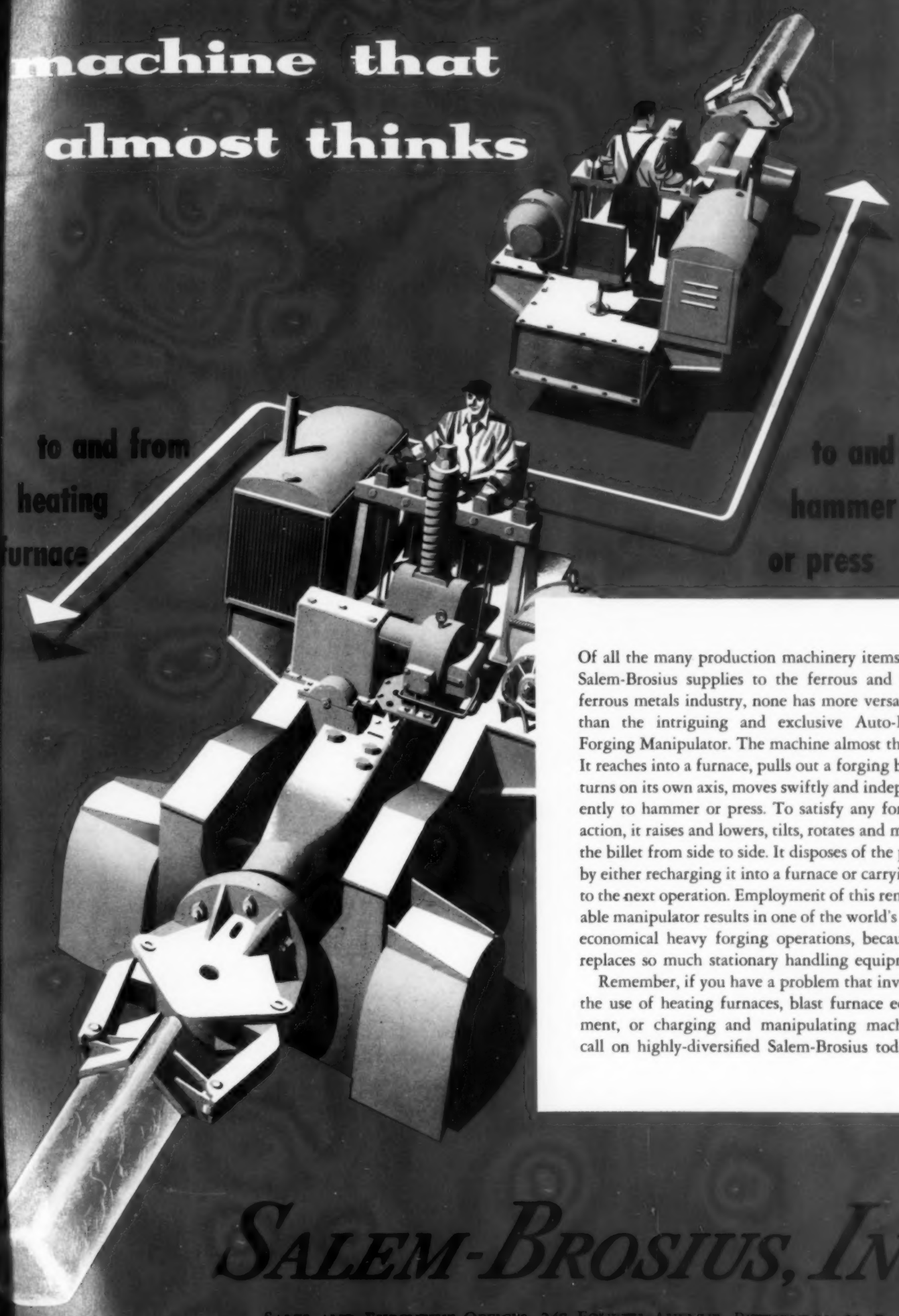


"Off-the-Shelf" Parts Kits make normal maintenance easier than ever. Each kit contains parts necessary to replace all load contacts and finger springs. Electrical interlocks also available in kit form.

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

SQUARE D COMPANY

machine that almost thinks



Of all the many production machinery items that Salem-Brosius supplies to the ferrous and non-ferrous metals industry, none has more versatility than the intriguing and exclusive Auto-Floor Forging Manipulator. The machine almost thinks. It reaches into a furnace, pulls out a forging billet, turns on its own axis, moves swiftly and independently to hammer or press. To satisfy any forging action, it raises and lowers, tilts, rotates and moves the billet from side to side. It disposes of the piece by either recharging it into a furnace or carrying it to the next operation. Employment of this remarkable manipulator results in one of the world's most economical heavy forging operations, because it replaces so much stationary handling equipment.

Remember, if you have a problem that involves the use of heating furnaces, blast furnace equipment, or charging and manipulating machines, call on highly-diversified Salem-Brosius today.

SALEM-BROSIUS, INC.

SALES AND EXECUTIVE OFFICES: 248 FOURTH AVENUE, PITTSBURGH 22, PA.

BROSIUS DIVISION, PITTSBURGH 15, PA. SALEM ENGINEERING DIVISION, SALEM, OHIO

only at **DRAVO** can you get . . .

a **COMPLETE LINE** of

CRANE CAB COOLERS AND CONDITIONERS

No matter what radical temperature variations or atmospheric conditions occur in your industry, there's a Dravo Crane Cab Cooler or Conditioner available to protect your crane cab operator, safeguard his health, increase his efficiency and alertness and improve safety and production records in your operations.

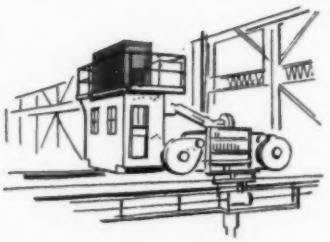
Dravo Crane Cab Coolers and Conditioners provide complete air conditioning, filter the air, remove dusts, dirt and fumes; heat the cab in winter, cool it in summer and provide constant ventilation the year around.

One Source of Supply— Easy Installation

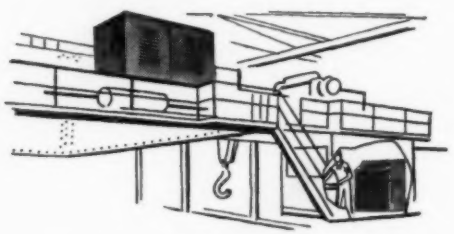
Dravo is your *one source of supply* for all crane cab coolers and conditioners. Units are quickly and easily installed with a minimum of downtime required. Parts are interchangeable on all units.

Available for Immediate Delivery

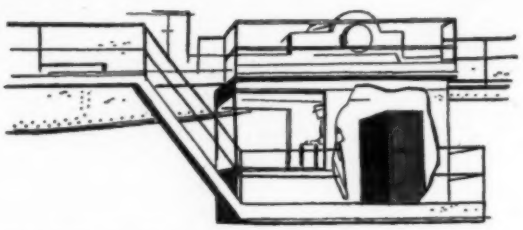
No delays in getting the units you want. For more information write for a complete catalog—or phone your nearest Dravo sales office and have our representative call on you.



SELF-CONTAINED COOLERS—mounted alongside the cab or on the cab roof. Only electrical leads and connections required. Thermostat control—fully automatic—maintains 85° F. temperature with ambient temperatures up to 175° F. Ideal for "hot spots" in steel and other metal-working industries.



SPLIT-TYPE COOLERS—installed on the crane in two sections—the heavy condenser unit *on the crane* wherever you want it—the light cooling section *in the cab* with the operator. Two sections joined only with refrigerant pipe and electrical connections.



SMALL HEATERS AND VENTILATORS—especially designed to filter dusts and dirt, remove fumes, provide constant ventilation, supply heat in winter. Ideal for cranes in quarrying, slag, cement and similar industries.

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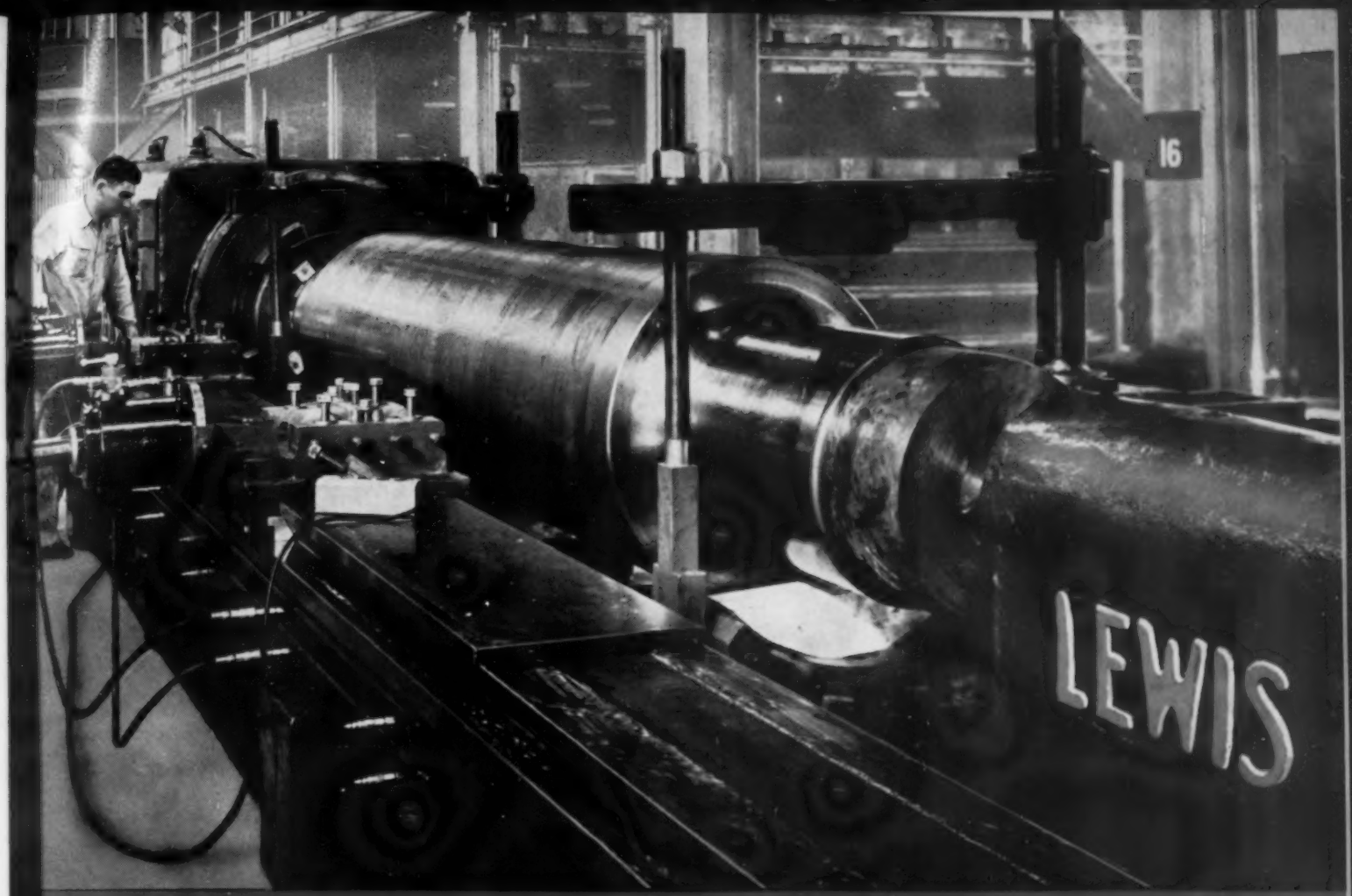
CORPORATION

602 Dravo Building, Fifth and Liberty Avenues, Pittsburgh 22, Pa.

ATLANTA • BOSTON • CHICAGO • CLEVELAND • DETROIT • NEW YORK • PHILADELPHIA • PITTSBURGH



BLAW-KNOX *Presents* THE NEW LEWIS HYDRAULIC ROLL LATHE

Acclaimed the *MOST IMPROVED* Roll Lathe in years!

Again proving that—"Whether the jobs are large or small, depend on Lewis to do them all."

LEWIS MACHINERY DIVISION

OF BLAW-KNOX COMPANY

PITTSBURGH, PA.

CHECK THESE OUTSTANDING ADVANTAGES

Reduces machining costs as much as 75 per cent if considerable metal is to be removed.

•

Depth of in-feed, lateral movements of cutting tool and movement of tail stock are all controlled by hydraulic pressure.

•

Tool traverses left to right and right to left producing a continuous spiral cut to any depth the tool will stand.

•

Predetermined hydraulic pressure eliminates wobble and reduces the shock that often ruins carbide-tipped tools. Also permits roughing-in of very hard surface rolls, formerly ground.

•

Roll supported on adjustable neck bearings—eliminating the weight on centers.

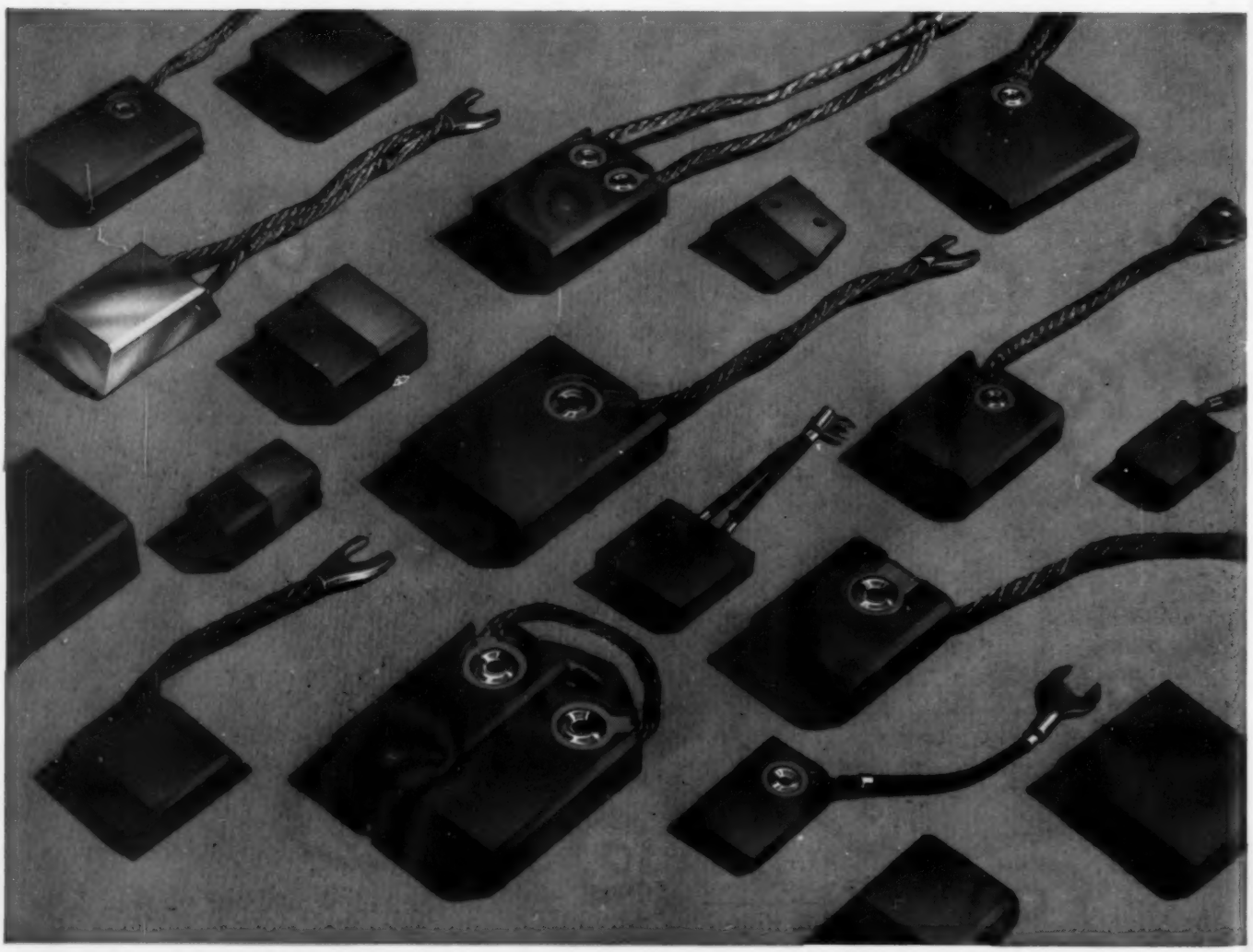
•

CAPACITY OF LATHE ILLUSTRATED—60 INCHES.

BUY USG BRUSHES

Try USG Brushes. They will solve those tough application problems for you. • Complete manufacturing facilities, plus continuous research and engineering make USG Brushes and Contacts the best you can use on all rotating electrical equipment. • USG BRUSHES can do a *better* job for you . . . Let us arrange a performance test to prove it.

Write today for 40-page catalog giving complete information on standard USG grades.



90-B

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

Amazingly simple way to measure BLAST AIR DEW POINT

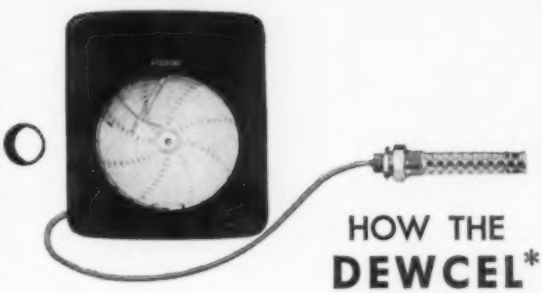
directly . . . accurately . . . continuously

Now you can measure or control the moisture content of blast air with simplicity and accuracy never before obtainable!

The unique Foxboro Dewcel*, an entirely new type humidity-sensitive element, has made this possible, at surprisingly low cost. Coupled with a Foxboro Recorder or Controller, the Dewcel offers these outstanding advantages:

1. Direct recording in dew point temperature, at existing pressure.
2. Wide working range — even operates at sub-zero temperatures.
3. Neither adds nor removes water from atmosphere.
4. No water box or circulation of air required.
5. Simplicity that eliminates maintenance.
6. High sustained accuracy.
7. Initial and operating economy.

Investigate Foxboro Dew Point Control. Write for Bulletin 407, and for Engineering Data Sheet 330-1 covering moisture control for furnace air blast. Foxboro Engineers will be glad to discuss the application of this control to your furnaces, at your convenience. **The Foxboro Company, 581 Neponset Ave., Foxboro, Mass., U.S.A.**



HOW THE DEWCEL* WORKS

The Dewcel element is a thermometer bulb (liquid-filled or electric-resistance type) jacketed with lithium-chloride-impregnated woven glass tape. Over this are wound two spaced gold or silver wires connected to an AC source. The lithium chloride absorbs moisture, allowing current to flow, generating heat, and raising the temperature. Equilibrium temperature is reached when vapor-pressure of the moist salt exactly balances that of the surrounding air or gas. The System translates this temperature into direct readings of dew point.

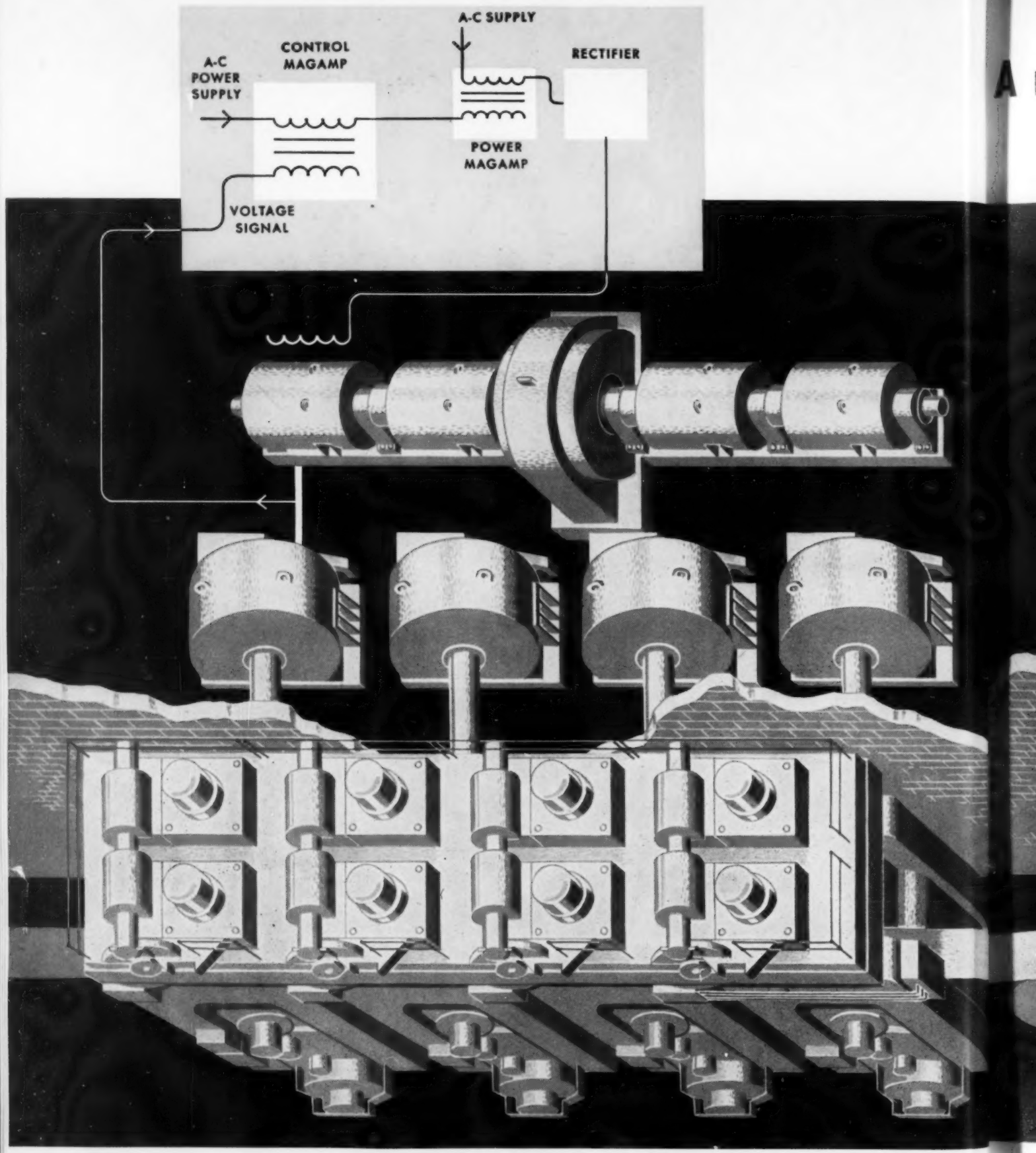
Thus, Foxboro Dew Point Instruments give direct readings or control of dew point from —50°F. to 142°F. at working temperatures from —40°F. to 220°F. Readings easily converted to absolute or relative humidity.

*Trade Mark

FOXBORO
REG. U. S. PAT. OFF.

RECORDING · CONTROLLING · INDICATING
INSTRUMENTS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND



Simplified Diagram Above shows the Magamp control for one stand of a tandem mill. All stands are regulated by matching the drives to a common reference bus. Stand speed is set by generator voltage. If it varies from reference voltage, the differential is fed into Magamp and there it is amplified. This large output current is rectified to d-c and fed into the generator field. The change in field strength then restores the motor speed to its correct value.

A major new development for steel mill drives

WESTINGHOUSE
MAGAMP REGULATOR

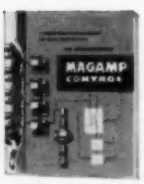
Here's a new drive regulating device with important possibilities for your mill. It's the Westinghouse Magamp®, a new application of the magnetic amplifier. Thoroughly tested on all kinds of mill and process drives, Magamp is ready now to help you increase production.

Below, a few reasons why Magamp has become a major regulating method:

1. Magamp acts fast—and it's highly accurate. On tandem cold-reduction mills, on hot strip mills, on rod and merchant mills, Magamp's speed means rapid response to sudden changes. Acceleration and deceleration are fast and even.
2. Magamp corrects without overshooting. It hits the right point and holds it. On reel control systems Magamp keeps tension constant as the coil builds up. On process lines—slitting, shearing, cleaning, pickling—Magamp precisely controls tension, voltage and speed under running conditions.
3. Magamp has no moving parts—no brushes, no bearings, no tubes to burn out. Because it's a simple static circuit, Magamp holds its settings. Maintenance is almost nonexistent.
4. Magamp is easy to install. Units are panel mounted and factory wired. No bedplate, no extra conduit, Magamp needs no warm-up. Flip the switch and it's ready to go.

CALL WESTINGHOUSE EARLY ON YOUR NEXT PROJECT

Magamp is another in Westinghouse's long line of solid achievements for steel mills. When you're planning a drive—or any other steel mill project—get in touch early with your nearby Westinghouse Office. J-94909



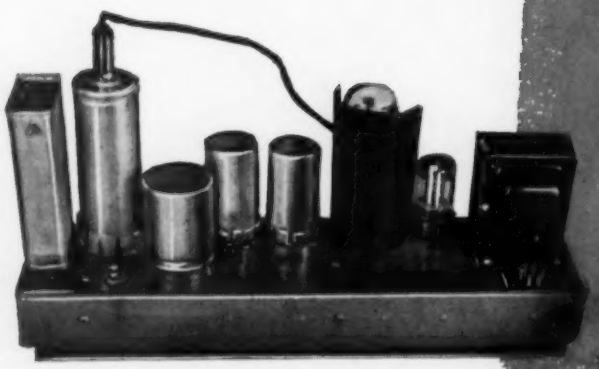
LEARN MORE ABOUT MAGAMP

Write us for this new free booklet about the Magamp Regulating System. You'll profit from the description, pictures and diagrams on how Magamp works—and can work in your mill. Ask for "The Westinghouse MAGAMP REGULATOR"—B-5468. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania.

YOU CAN BE SURE...IF IT'S
Westinghouse

MATCHED EQUIPMENT FOR STEEL PRODUCTION

A lot of Engineering for an Amplifier, but...



Good engineering shows in this Amplifier's wide range of sensitivities, and of impedances, thorough filtering and plug-in connection to the rest of the Speedomax instrument.

Good engineering shows in this Converter's phenomenally low noise level and in its long-lived performance.

Good engineering shows in this Slidewire's non-inductive winding and in absence of any flexible leads which might form inductive loops.

Good engineering shows in this balancing motor's small size, and in its torque ample to operate accessory control and signalling fitments.

it helps Speedomax to fit your ideas!

• Your needs and ideas put this electronic "tool" to work on an amazing variety of jobs. Controlling furnaces and peering into atoms; counting bottles and spying on the weather; taking the "shine" out of rayon or putting it on hardware, to name six out of thousands of uses. For, in general, if you can feed Speedomax a tiny electrical signal, representing the condition you wish to measure, the instrument will not only put "calipers" on it, but will amplify it enormously to direct anything that can be directed through electrical or pneumatic means.

The Speedomax way of handling this job provides particularly accurate results and an especially good fit in meeting your individual ideas. For instance, there's the matter of receiving the signal in a way suited to its size—or, more usually, to its smallness.

We have no less than twenty-three carefully-engineered Speedomax Amplifiers covering a wide range of sensitivity and impedance levels. One Amplifier in the series enables the Speedomax to respond to a signal of only 10-16 watt—one ten-billionth of a microwatt. No other recorder amplifier comes within 3 magnitudes of this figure. Such sensitivity means corresponding accuracy in detecting the tiny unbalance—called "error" by circuit engineers—which actuates the rebalance system.

In terms of power, all 23 Amplifiers deliver the same—5 or 6 watts. This is from 2 to 4 times the output of other recorder amplifiers; permits a more powerful balancing motor. And the Amplifier-Motor team provides an especially high torque gradient just where it's needed—centering around the balance point—for prompt, positive balancing and easy, effortless operation of a "heavy" load of control or signal devices in the motor shaft.

The Speedomax story for industry is told in Catalog ND46(1); for Research, in Tech. Pub. ND46(1). We will send either on request; address our nearest office or 4942 Stenton Ave., Phila. 44, Pa.

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Expansion program of this long-established firm has many features to attract outstanding recent graduates in engineering and science. Opportunities are in sales field engineering, product and application engineering, research, advertising, market development. Widely-respected policies assure recognition of progress and achievement. Address Personnel Manager for preliminary interview at nearest of 17 L&N offices.

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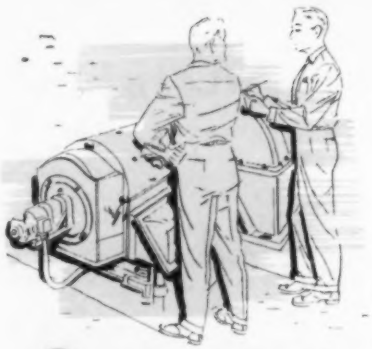

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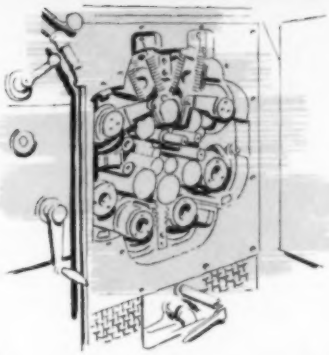

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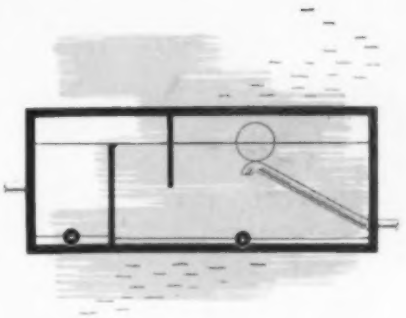
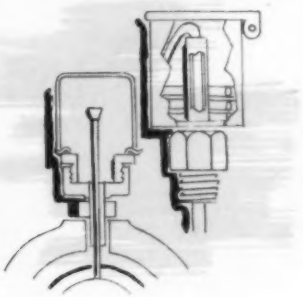


3 filtering and purification



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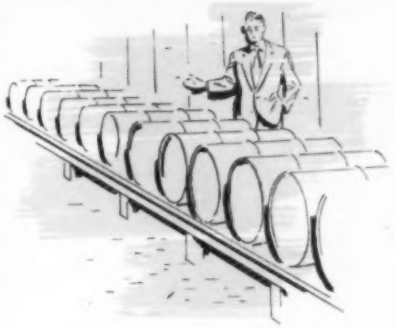

5 storage and handling

6 individual problems

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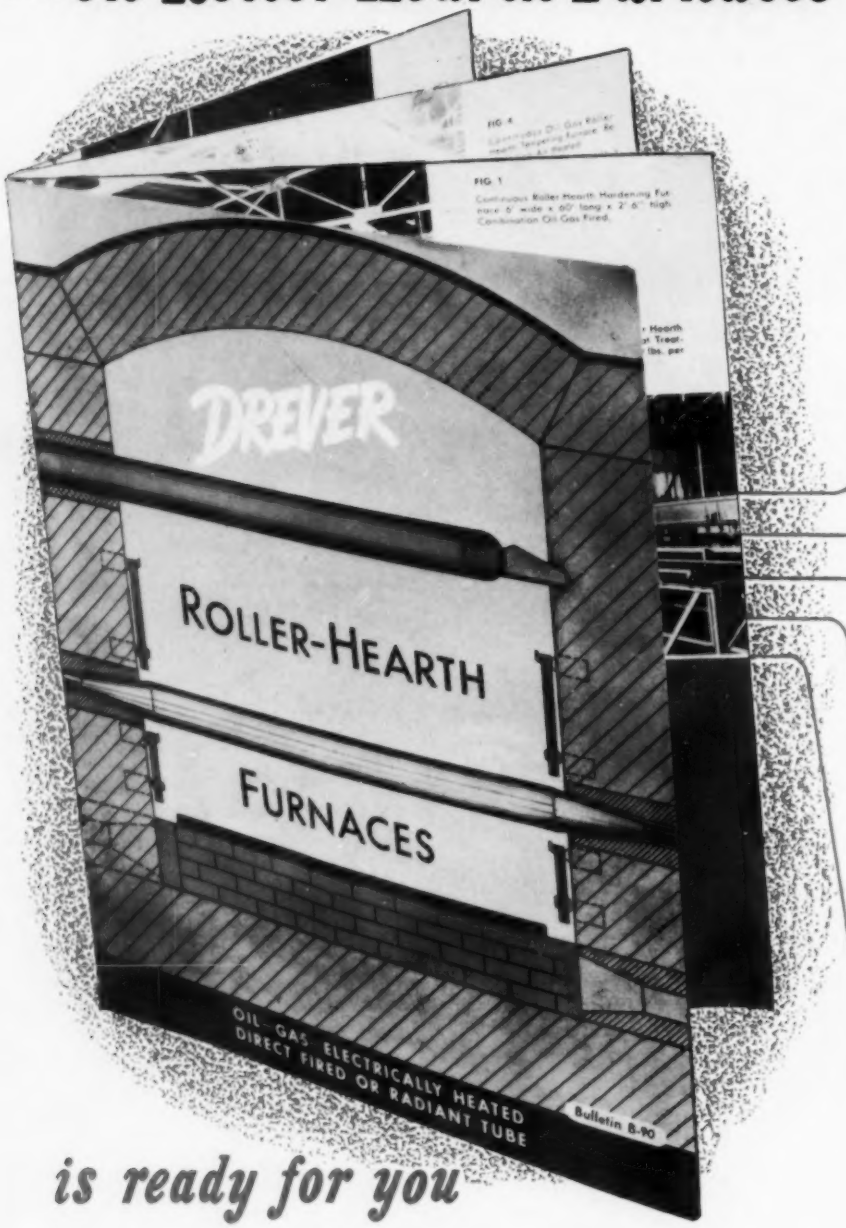
Bulletin B-90

...on Roller-Hearth Furnaces



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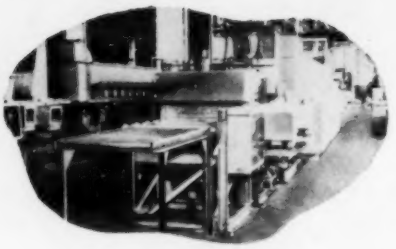

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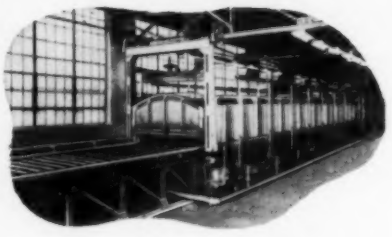

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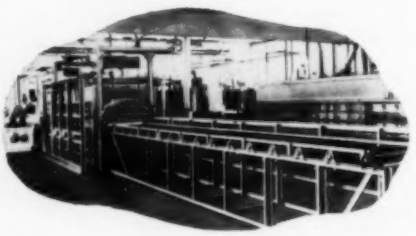

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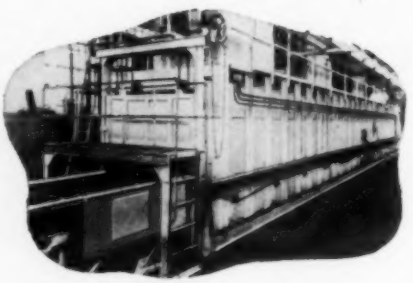

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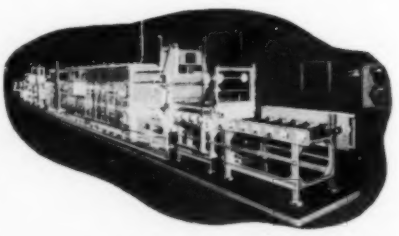

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5

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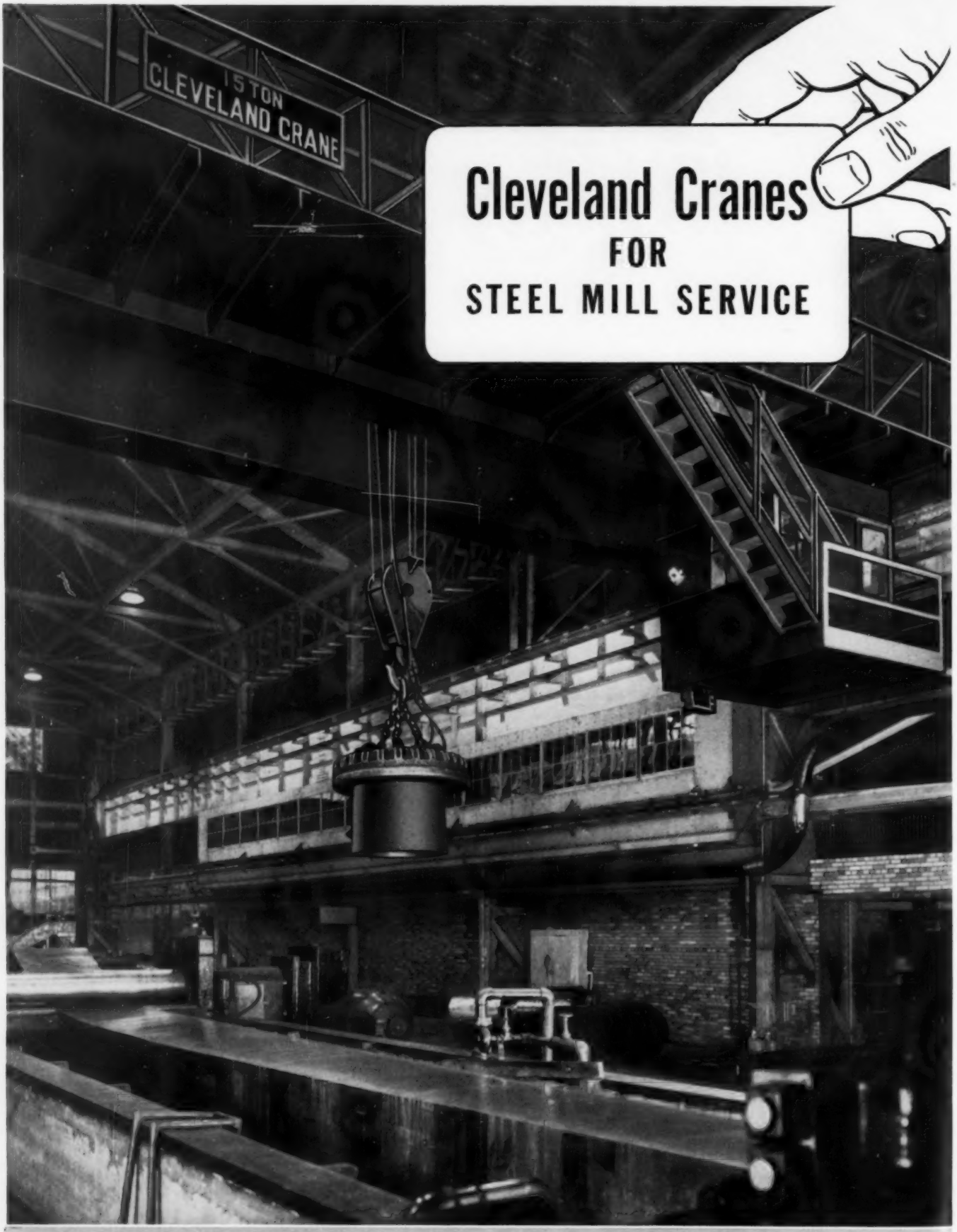

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Crops *and* Shorts

NOW that we are into the new year far enough to have recovered from welcoming its arrival and to have broken our resolutions, we find that we have a new federal administration — the first Republican administration for 20 years. Indications promise that the new administration will be built up of capable men, and will have different ideas of responsibility, integrity, government spending, and many other aspects of public office. There will doubtless be a turn toward the principles of thrift, hard work, pay-as-you-go, incentives for business enterprise, and rising productivity — principles that are responsible for the American system. But after the spree we have been on, the sobering up must involve some hang-over. The new leaders are not magicians, so let's not get too impatient if everything isn't rectified immediately.

▲

A sign in front of a church recently announced the sermon text as: "What shall it profit a man if he gain the whole world . . . ?"

With taxes as they are at present, that is quite a problem.

And speaking of taxes, we wouldn't mind paying as we go so much if we just knew where we were going.

▲

ADMIRAL Ben Moreell, of Jones & Laughlin Steel Corp., says: "I believe that the greatest error of our times is that we have given to political employees the coercive power to make us conform to their ideas of what is good for us."

▲

A report issued by the National Society of Professional Engineers outlines how numerous companies employing some 106,000 engineers are meeting shortages of trained personnel. Their methods include standardizing routine engineering jobs so they can be done by supporting personnel, improving engineering-management communications, and using auxiliary sources of engineering talent from outside organizations.

These activities help to stretch the existing supply of engineers and have been in use to varying extent in industry for some time. They do not solve industry's problem, however, of how and where to train the young engineers. The gradual change in engineering school curricula, eliminating many of the so-called "know-how" courses and expanding the humanities courses, has increased the need for training in industry.

Actually, there is little agreement in the training activities in industry, and the steel industry is, in general, rather behind other industries in their programs. This is reflected in the difficulty the steel industry is experiencing in getting new engineering graduates — experience which emphasizes the necessity of making the industry more attractive to the young engineer.

▲

AN item in the house organ "Curtis Courier" states that in England, prior to the introduction of coffee, the favorite breakfast drinks were porter and rum.

Just goes to show that modern innovations aren't always improvements.

▲

MENTION has been made in some quarters of a new course of professional training, known as publication engineering. It is described as a combination of engineering, writing and publishing. The need for training of this sort is felt to stem from the complexity of modern scientific and industrial equipment, which is difficult for lay writers to understand, and from the inability of most engineers to write extensively and well, a skill that is becoming more and more important in industry.

▲

IN a recent address, L. L. Colbert, president of Chrysler Corp., said: "Our economic and political order has survived war, the threat of war and the competition of totalitarian, socialistic economies. Invariably it has performed best when allowed to operate with a minimum of restrictions. Ill-advised and unnecessary tampering can in time dry up its basic productive force, which is the incentive of profits. Profits are not only the incentive to produce, but they provide means for more production.

▲

IT'S a fact that you never could take money with you, but there was a time when the government would let you have some while you were here.

▲

ACCORDING to figures compiled by the American Iron and Steel Institute, annual capacities of the iron and steel industry in the United States as of the start of 1953 are 117,547,470 net tons of steel, 79,380,240 net tons of iron and 71,181,190 net tons of coke. Expansion programs now under way will raise these figures to approximately 123,000,000 tons of steel, 83,000,000 tons of iron and 74,500,000 during the next two years.

▲

THERE are numerous cases of internal friction in union locals that result in trouble for plant management. The majority of cases stem from the "outs" trying to embarrass the "ins," in the hope of supplanting them at the next union election. Regrettably, these efforts sometimes take dangerous courses, even to stirring up racial unrest.

News in 1940—production necessity today

ONLY a few years ago, the science of sensitive, accurate measurement was limited to laboratories. But today, this science is practiced every day in thousands of industrial plants by factory men . . . who don't have to be instrument experts.

Production men wanted to put this science to work, for they had long known that many processes would function at greater efficiency if temperature, pressure and other variables could be more accurately maintained. Although these potential benefits could be proved in the laboratory or in pilot plants, they could seldom be exploited fully in actual production.

Milestone in measurement

One of the main reasons was that existing industrial methods of measurement were not sufficiently accurate, sensitive or fast. Instruments with delicate mechanical balancing systems suffer inherent limitations . . . always require a compromise between sensitivity and ruggedness . . . and can provide only periodic measurements.

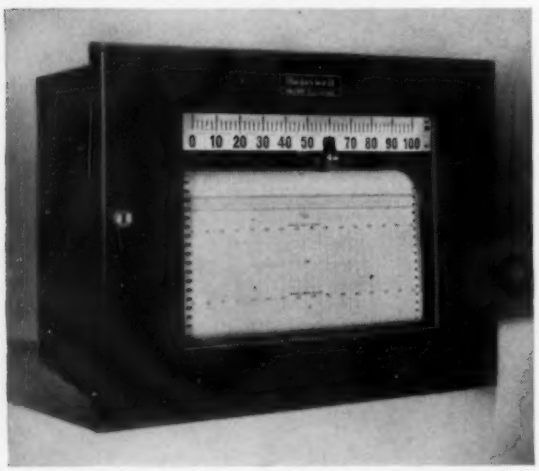
Then, in 1940, the advent of *ElectroniK* instruments swept away these limitations. By adopting an entirely new approach—electronic continuous balancing—these instruments revolutionized the concepts of industrial measurement. They placed laboratory accuracy and sensitivity at the disposal of the production man . . . with all the simplicity and ruggedness demanded by industrial service . . . *plus* speed of response never before economically practical.

Proved by years of performance

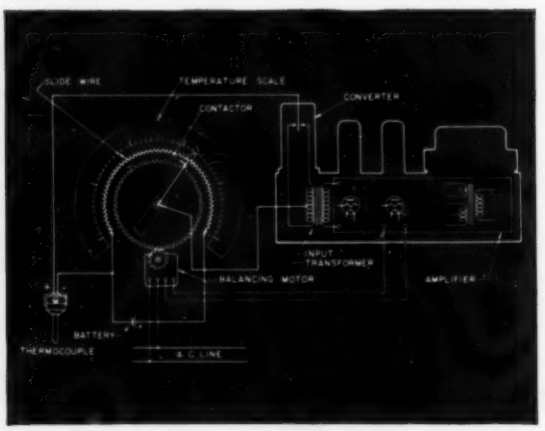
In the past thirteen years, thousands of plants have discovered almost endless applications where the superior performance of these instruments helps to improve operations. The more they learn about *ElectroniK* instruments, the more they call on them for increasingly complex tasks of measurement and automatic control.

Since 1940, the *ElectroniK* family has grown to encompass a host of new indicating, recording and controlling models . . . capable of measuring scores of different process variables . . . equipped with the most advanced types of automatic control. In anticipation of the needs of the future, Honeywell's intensive development program is bringing to readiness even more advanced equipment for tomorrow's process control problems.

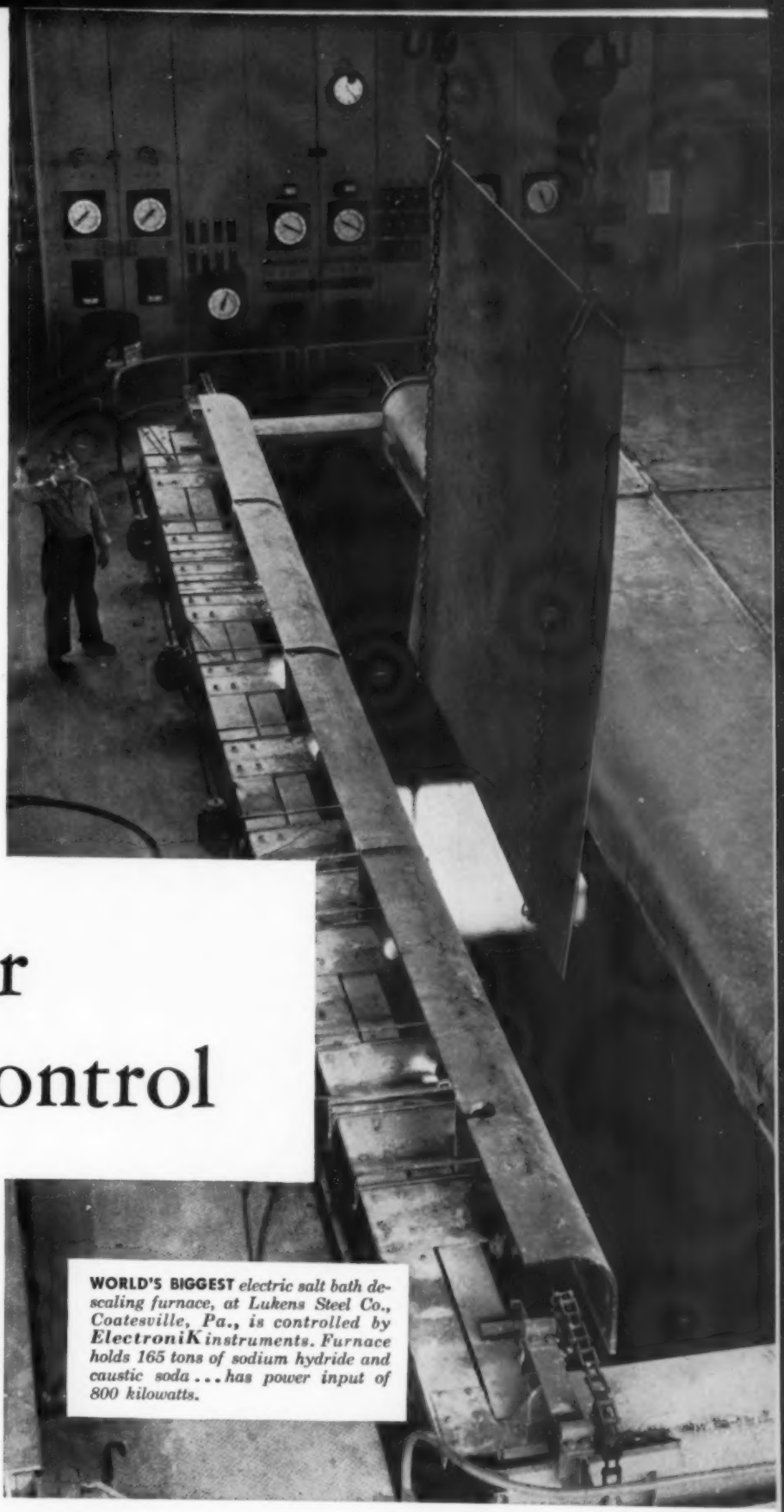
Big furnaces p
with



A FAMILIAR SIGHT *to thousands of production men, scientists and engineers is this strip-chart ElectroniK Recorder, one of a complete family of indicating, recording and controlling instruments.*



POWER PLANT *of ElectroniK instruments amplifies a millionfold the minute electrical signals from thermocouples and other sensing elements.*



TYPICAL of today's trend to greater plant capacity is the huge sodium hydride descaling furnace which Lukens Steel Co. uses to clean hot-rolled clad sheets. For this critical operation, *ElectroniK* instruments once more were chosen to regulate vital furnace temperatures.

On load after load, the *ElectroniK* controllers hold bath temperatures exactly at the specified value . . . prevent overheating which might cause warping and under-heating which would slow production. *ElectroniK* accuracy pays dividends, in greater output and in top quality of finished sheets. And *ElectroniK* industry-proved design assures uninterrupted operation of this critical process.

Throughout the steel industry . . . applied to blast furnace, open hearth, soaking pit, reheating, annealing and other furnace control, you'll find thousands of these instruments performing with the highest efficiency.

produce better *ElectroniK* control

When you're planning new facilities, or modernizing existing equipment, plan on utilizing the proved performance of *ElectroniK* instrumentation. Call your Honeywell engineer for experienced consultation . . . he is as near as your phone.

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WORLD'S BIGGEST *electric salt bath descaling furnace, at Lukens Steel Co., Coatesville, Pa., is controlled by* **ElectroniK** *instruments. Furnace holds 165 tons of sodium hydride and caustic soda . . . has power input of 800 kilowatts.*

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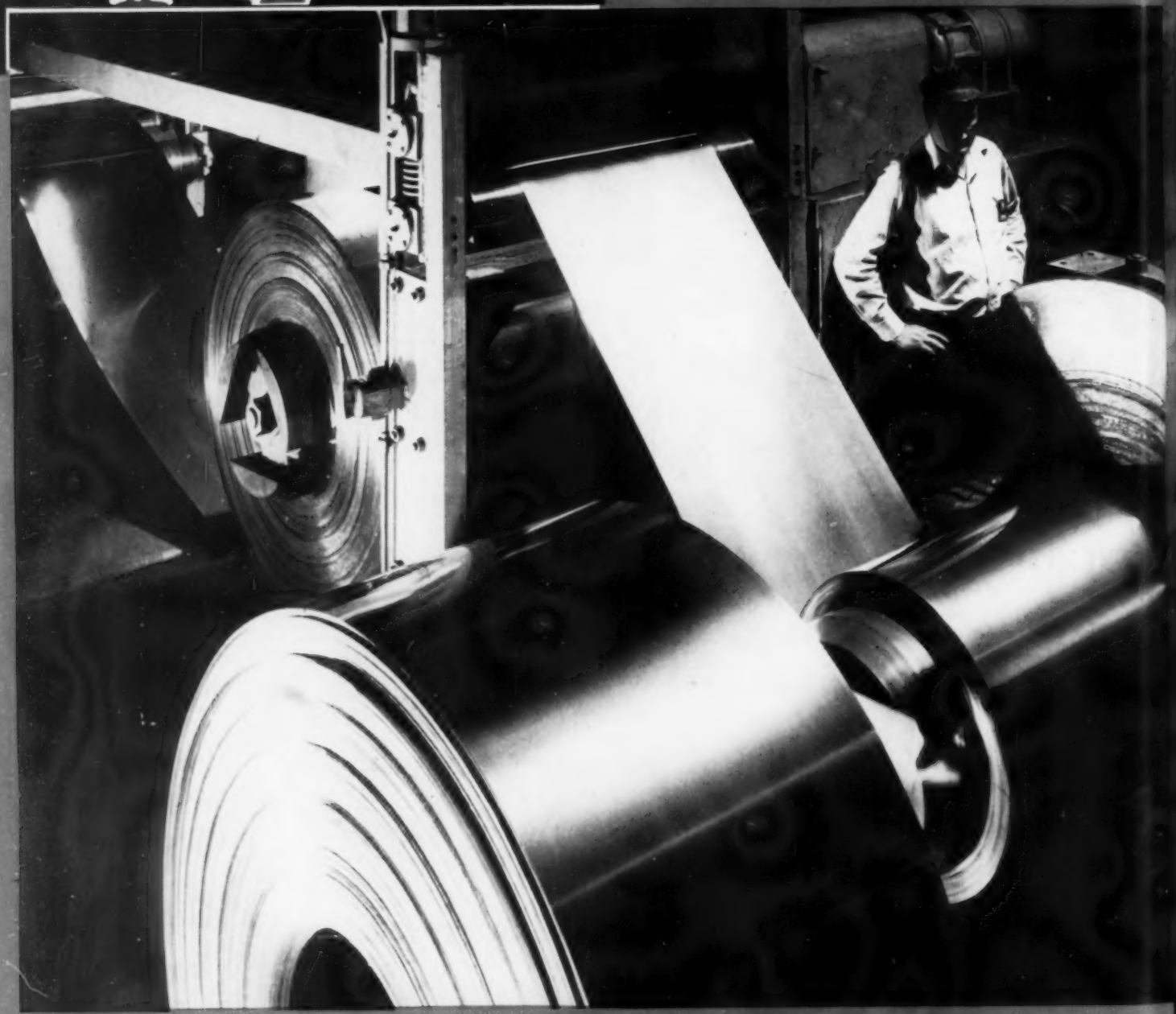

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Iron and Steel ENGINEER

JANUARY, 1953 VOLUME XXX NUMBER 1

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BELGIUM	2
BOLIVIA	2
BRAZIL	30
CANADA	50
CHILE	11
CHINA	17
COLOMBIA	7
DENMARK	2
ENGLAND (BR. ISLES)	70
FINLAND	4
FRANCE	4
HAWAII	1
ITALY	16
INDIA	9
JAPAN	2

Country	No. of Furnaces
MEXICO	20
NEW CALEDONIA	2
NEW ZEALAND	4
NORWAY	2
PANAMA CANAL	2
REP. OF PANAMA	1
PERU	4
PHILIPPINE ISLANDS	3
POLAND	3
PORTUGAL	4
RUSSIA	69
SPAIN	26
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TURKEY	2
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Project Engineer
Spang-Chalfant Division
National Supply Co.
Ambridge, Pa.

. . . . now developed is a fully proven and economical production method for heat treating high strength casing pipe . . . .

▲ SINCE 1947 a continuous quench and draw line has been successfully producing high strength oil well casing from plain carbon steel at the Ambridge, Pa. plant of Spang-Chalfant division of The National Supply Co. During these five years, over 80,000 tons or more than 7,000,000 ft of quenched and tempered casing have been produced on this equipment.

A high strength casing, API Grade N-80, used in deep oil wells usually is made of a normalized and drawn high manganese, molybdenum steel. With the recent restrictions on the use of molybdenum and the overall effort to conserve all alloying elements, the development of a process which reduces the amount of manganese required and eliminates the use of molybdenum, was indeed timely. Producing the 80,000 tons of casing by quenching and tempering has resulted in the saving of over 300,000 lb of molybdenum and nearly 1,500,000 lb of manganese.

A secondary objective for the use of this continuous heat treating equipment was for the production of casing having a minimum yield strength of 110,000 psi for use in oil wells to depths of 20,000 ft or more. Considerable experimental work has been conducted to produce this grade of casing both in the non-upset and upset end types. These experiments have been quite successful and the material produced has very satisfactorily met all the physical properties required for this higher grade of casing.

The continuous heat treating line contains a series of high intensity radiant gas furnaces. Pipe having a maximum diameter of 9⅝ in. outside diam and a maximum length of 50 ft can be heat treated in this equipment. The sizes of pipe processed so far have been all casing sizes from 4½ through 9⅝ in. outside diam with several wall thicknesses in each size.

The heat treating line consists principally of the following:

1. Twelve high thermal release radiant gas-fired furnaces arranged in two sections of six furnaces each. The first or high heat section heats the pipe up to the required quenching temperature, and the second section performs the draw or tempering.
2. Eight carburetors for preparing a pre-mixed fuel which is delivered under pressure to the radiant burners.
3. Temperature control and recording equipment for each of the 12 furnaces plus a recording radiation pyrometer that furnishes a continuous record of the pipe quenching temperature.
4. An annular orifice quench head with pumping and filtering equipment.
5. Conveyors and handling tables equipped with electrical, mechanical, and pneumatic devices necessary to accomplish automatic travel of the pipe through the high heat furnaces, quench head, and draw furnaces.

Figure 1 shows an overall picture of the heat treating line. The carburetion and temperature control equipment is located in a room outside the wall to the right of the furnaces. The eight 6⅝ in. outside diam pipes seen along this wall carry the gas-air mixture from the eight carburetors to their respective furnaces.

SEQUENCE OF OPERATIONS

The sequence of operations in the continuous quenching and drawing of pipe in this equipment is as follows: Bales of pipe are loaded onto the rear of the inlet table

*Now with McKay Chain Co., York, Pa.

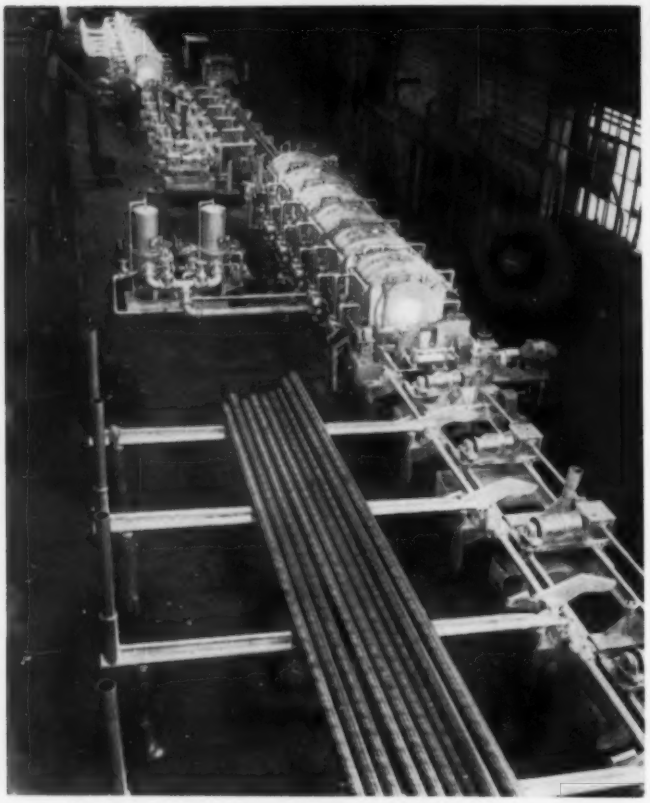


Figure 1 — Overall view shows continuous heat treating line.

shown in the foreground of Figure 1 by overhead traveling crane. The bales are broken down and spread out manually. The horizontal skids of the table are slightly inclined so that the pipe will roll by gravity down against stops at the conveyor end of the table.

From here on, when the controls are set for automatic operation, the pipe is kicked onto the inlet conveyor, positioned, heated to the quenching temperature in the quench furnaces, water quenched, drained, tempered in the draw furnaces, and kicked into receiving bucks automatically. Each of the various sections of the handling equipment can be operated manually if desired. Manual operation is occasionally necessary on the intermediate table between the quench and draw sections due to crooked pipe not actuating the control paddles properly.

When the rear end of a pipe going through the quench section releases the second paddle from the lead furnace, the transfer fingers lift the next pipe on the inlet table over the stops and onto the inlet conveyor. The inlet conveyor of the quench section has double rolls, the first row of which is used to carry the pipe against a positioning stop. When the rear end of the beforementioned pipe being heated for quenching releases the paddle next to the furnace, the transfer fingers kick the positioned pipe onto the second row of the inlet conveyor. The paddle and the stop are so located as to provide about 18 in. spacing between pipes. The reason for this will be explained in connection with the quenching operation.

Figure 2 shows a closer view of the heating and quenching equipment. The pipe is heated to a quenching temperature of approximately 1600 F as it passes through the six furnaces of the quench section. A radiation pyrometer sights on the heated pipe as it emerges from No. 6 furnace. A continuous record of the quenching temperature of each pipe is recorded on a chart in the control room.

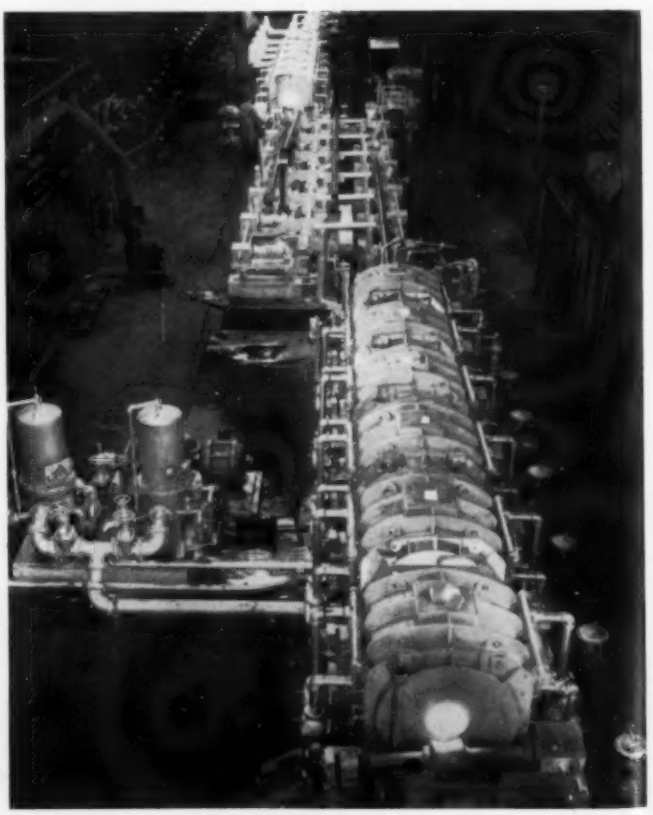
The pipe is water-quenched cold as it passes through the quench head which is located 2½ ft from No. 6 furnace.

After passing through the quench head, the pipe continues down the third conveyor section until its front end depresses a paddle which actuates the kick-off fingers. The pipe is pushed off the conveyor rolls onto an intermediate table leading to the draw line. Depending on the size pipe, this table can hold three to six pipe.

Movement of the transfer fingers lifts the pipe over stops onto the fourth conveyor section which has a double set of rolls. The pipe advances against a stop, depressing a paddle which actuates the elevating mechanism. The rear end of the pipe is raised about 15 degrees to allow the water to run out. The pipe is held inclined by a timer set to allow the preceding pipe to nearly clear a paddle located in front of the first draw furnace. At the expiration of this time, the rear end is lowered down on the conveyor rolls. When the rear end of the preceding pipe going through the draw furnaces releases the above-mentioned paddle, the transfer fingers lift the pipe off the drain rolls onto the inlet rolls to the draw line.

The speed of the inlet conveyor section to the draw line (Section No. 4) is slightly faster than that of the two following Sections, No. 5 and No. 6. This enables the incoming pipe to catch up and butt against the pipe already in the furnace. This reduces overheating of ends during the draw treatment. The open ends would receive radiation, both internally and externally. Al-

Figure 2 — In the quench section, the pipe is heated to 1600 F, as it passes through the six quench furnaces.



though most of the pipe is processed uncropped and the ends are ragged, they still fit together well enough to prevent over-drawing for more than three or four in. This amount is removed when the pipe is cropped. Cropped or square-cut pipe is sometimes processed, but it is necessary to re-cut 2 to 3 in. off each end after heat treatment. Butting the pieces together would eliminate all end overheating if all the pieces were straight. However, since all of the pipe is somewhat crooked after quenching, the resulting misalignment allows 2 to 3 in. to be overdrawn.

There is a speed-up paddle located along the No. 6 conveyor section at a position which will speed up this section of conveyor rolls temporarily after each piece has passed completely through the draw line. This pulls the pieces far enough apart to allow time for the kick-out fingers to push the pipe off the conveyor rolls without disturbing the piece following.

The pipe is pushed off the conveyor, rolls on short skids, and drops into receiving bucks. Bales having the same pieces as originally brought to the furnace line are again made up with chains, tagged and taken away by overhead crane.

MEN REQUIRED

The line is operated by two men, an operator and helper. The operator sees that the automatic operations are functioning properly and that the pipe receives proper treatment. He makes any necessary adjustments in temperature and speed. The helper assists the operator, attends to the pipe on the inlet table, and bales up and sends away the processed pipe. Various changes required for processing different pipe sizes are made by these two men.

Figure 3 shows a general arrangement of the continuous heat treating line. The overall space required for the processing equipment is about 26 × 225 ft or 5,850 sq ft. An additional space of 17½ × 80 ft or 1400 sq ft is required for the carburetor and control room, giving a total area of 7250 sq ft.

There are six conveyor sections, each section driven by an independently controlled line shaft. The first and last sections contain six rolls each, and the other four sections have seven rolls. Rolls in the furnace sections are located between furnaces on 5½-ft centers. Rolls in the other sections are on 7 and 8-ft centers.

The total length of each furnace section is 32½ ft. The individual furnaces are 4½ ft long overall, with 3 ft 8 in. inside between end firebrick walls. There is 13-in. spacing between furnaces.

During processing, a length of pipe travels lineally a distance of 185 ft.

CONVEYOR SYSTEM

Each of the several conveyor sections is driven by a 3-hp variable speed motor which is controlled by an individual rheostat. The roll speeds are adjusted so that the rate of travel through the quench and draw sections is the same. After the individual rheostats are adjusted to give desired speeds, one section relative to another, the overall speed of the line is adjusted by a single rheostat controlling a Ward-Leonard motor-generator system. The Ward-Leonard system is used to furnish constant voltage power to the individual conveyor motors so that all conveyor speeds will remain constant. A speed range of 2.5 to 12 fpm can be obtained by rheostat adjustment.

The three sets of conveyor rolls in the quench section are run at the same speed. No. 4 section leading into the draw furnaces is run slightly faster than 5 and 6 sections to cause the pipe to butt together as they go through the draw line.

No. 2 and No. 5 conveyor sections, containing the rolls which are between the furnaces and which are subjected to high heat, have water cooled roll shafts.

The axes of all conveyor rolls are skewed 7 degrees from a perpendicular to the line of travel of the pipe. This produces rotation of the pipe as it travels through the furnace sections. When the equipment was originally installed, the axes of the rolls were perpendicular to the

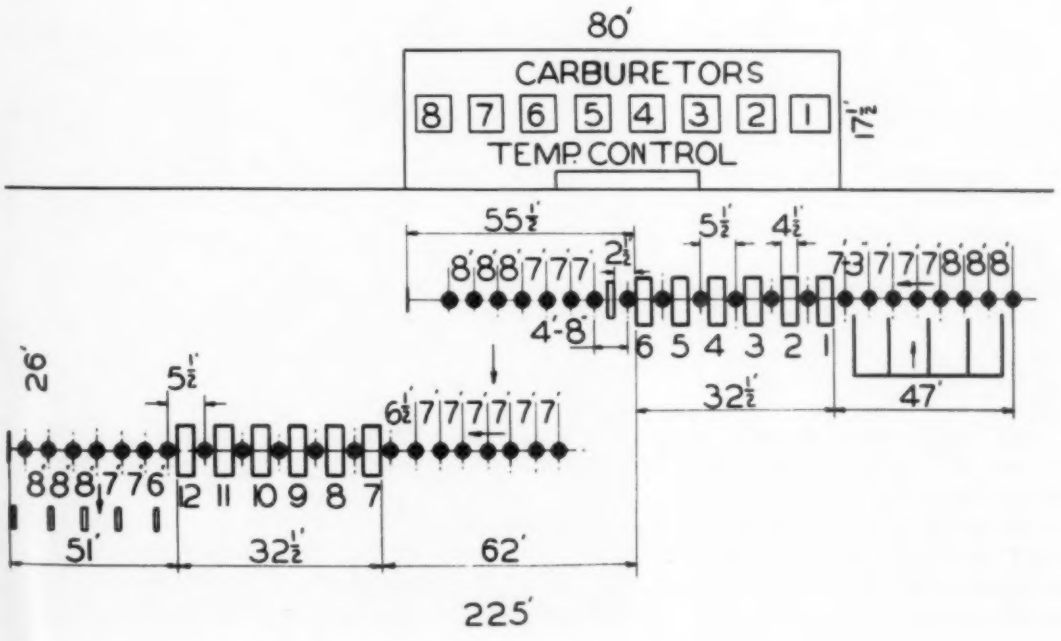


Figure 3 — General arrangement of the continuous heat treating line.

line of travel, giving no pipe rotation. It was found that the heating of the pipe circumferentially was not uniform since the furnaces are fired only from the two sides. The 7 degrees skewness was the most that could be obtained without relocating the furnaces and changing the gear connections along the line shaft. While the amount of rotation produced by this method is very slight, about one revolution of 7-in. pipe in 15 ft of travel, the improvement in uniformity of heating was quite noticeable. It is felt that in any new installations of similar equipment, considerably more rotation of the pipe would be beneficial.

The elevating mechanism for draining the pipe and all kick-off and transfer fingers are operated by air cylinders.

FURNACES

The 12 radiant gas-fired furnaces or chambers are arranged in two sections of six each. Furnaces 1 through 6 compose the high heat section for heating the pipe to a quenching temperature of about 1600 F. Furnaces 7 through 12 compose the draw line where pipe temperatures of 1050 to 1250 F are obtained, depending on the material being processed.

During the normal operation, the 12 furnaces use about 24,000 cu ft of natural gas per hr. Of this, 16,500 cu ft is used by the quench section and 7500 cu ft by the draw section.

The average gas consumption for all sizes processed is equivalent to 3,750,000 Btu per ton for the combined quench and draw treatment.

These radiant type furnaces are designed to heat at very high rates. This speed-heating is obtained by the pipe being exposed to radiation from very high temperature heat sources. Two rows of burners located on each side of the furnace provide the energy for this fast heating. The ceramic burner cups and tips operate at temperatures of 3000 F or higher.

Considering the quench section where an ultimate pipe temperature of 1600 F is desired, the high thermal gradient between the pipe and the burner cups results in the pipe being heated very rapidly.

The first five furnaces of the quench section are high heat furnaces, each having 24 burners. The maximum operating temperature for these five is 2500 F. The temperature is measured by radiation pyrometers focused on the inside of sighting tubes which extend through the furnace walls. No. 6 furnace, with a top operating temperature of about 1800 F, has only 20 burners and these are smaller in size.

The compressed fuel for each of the first four quench furnaces is supplied by a 60,000-cfhr carburetor. The fuel for both No. 5 and 6 furnaces is supplied by one 60,000-cfhr carburetor. An individual high heat furnace when operating wide open will use 3500 cfhr of gas.

In the draw section, the first two furnaces (No. 7 and 8), are high heat, maximum operating temperature 2500 F, each supplied with fuel from a 60,000-cfhr carburetor. Furnaces 9 through 12 are low heat furnaces, each having only 10 burners, with an operating maximum of 1600 F. These four furnaces are all supplied by one 25,000-cfhr carburetor and are controlled using iron-constantan thermocouples instead of radiation pyrometers as are used in all the other furnaces.

Figure 4 is a view of the carburetor and temperature control room. The natural gas-air fuel is mixed in the proper proportions in the eight carburetion units and fed to furnace manifolds under 2½-psi pressure. Each carburetion unit or so-called turbo combustion controller consists principally of a gas-air mixer and a turbo compressor. Since a highly combustible gas mixture is being handled, the system is equipped with ample blow-out relief units and fire checks. Seven of the units are rated at 60,000-cfhr capacity of mixed fuel and are powered by 40-hp motors. The eighth unit has a capacity of 25,000 cfhr and is operated by a 15-hp motor.

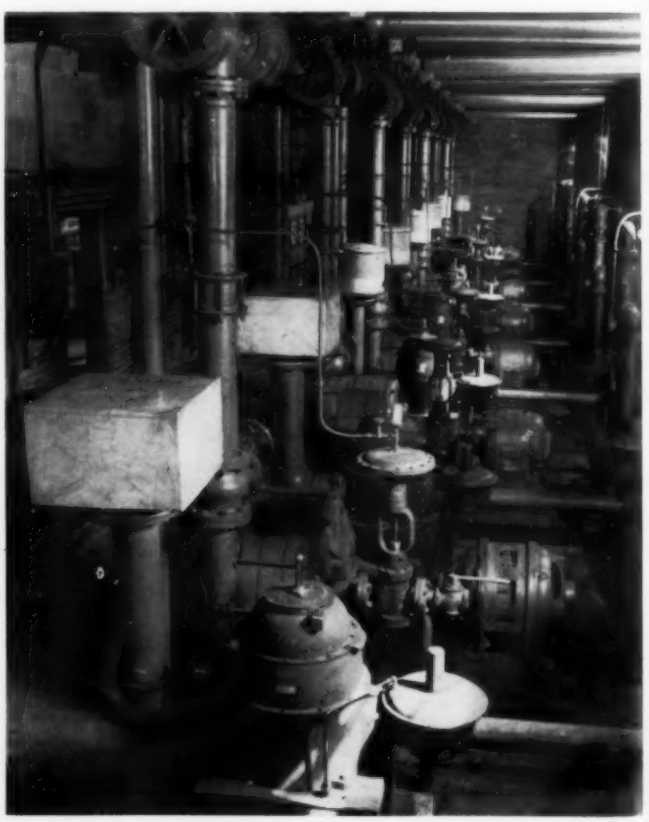
Air is drawn through filters into the mixer by the turbo compressor. The air and gas are intimately mixed in constant proportions and delivered to the furnace burners under pressure through air controlled diaphragm valves. Temperature control is obtained by throttling of the fuel by the diaphragm valves. These diaphragm valves are operated by air pressure which is regulated by temperature control equipment.

Figure 5 shows the instrument panel containing the temperature controllers and recorders for the 12 furnaces. The instrument at the upper left records the quenching temperature of each pipe. At lower left is a recording gas meter for measuring the total gas consumption of the line.

FURNACE TEMPERATURES

Experience has shown that the best method of heating for quenching in this continuous line is to drive as much heat as is possible into the pipe in the first three fur-

Figure 4 — The gas and air fuel is mixed in eight carburetion units.



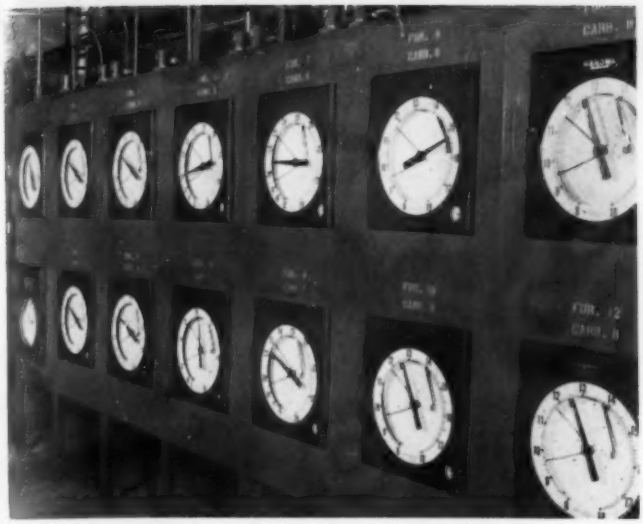


Figure 5 — Controllers and recorders for the twelve furnaces are mounted on one panel.

naces. These furnaces are usually operated at full capacity or wide open. The following three furnaces are throttled down, each one lower than the preceding, with No. 6 operated at 1600 F. Practically all the heating is done in the first four furnaces, while the last two serve as soaking furnaces to produce a uniform pipe temperature of 1600 F. Typical temperatures for the quench section are given in Table I.

With the furnaces operating at these temperatures, the conveyor speed is adjusted to obtain a final pipe temperature of 1575 to 1600 F.

When pipe having upset ends is processed, it is necessary to overheat the pipe body in first part of the furnace section in order to drive enough heat into the upsets within a reasonable length of time. During travel through the last two or three furnaces, the upsets continue to come up to heat while the pipe body decreases in temperature. By the time the pipe leaves the last furnace and reaches the quench head, there is little difference between the temperature of the pipe body and that of the upsets. Since upset material must be processed at reduced conveyor speeds because of the heating limitation, the production of the line could be greatly increased by the addition of two or three more furnaces in the quench section. This has not been done as the processing of upset material so far has been on a limited and experimental scale.

The draw line is operated to produce pipe temperatures in the usual range of 1100 to 1150 F depending on the chemistry of heats being processed. The method of heating is quite similar to that used in the quench line. The first two furnaces are operated at high temperatures to drive the heat in rapidly. Typical temperatures for the draw section are given in Table II.

No. 7 furnace, the lead furnace of the draw line, is controlled at 2100 F instead of being run at full capacity. This lower temperature is maintained to reduce the damage done by flying scale on the burner cups. Some light scale remains on the pipe after quenching and much of this is blown loose when the pipe enters the draw line. This scale will stick to the ceramic burner cups if they are at very high temperatures. The iron oxide scale causes the ceramic material to break down and the cups become badly pitted and require replacement.

The second furnace in the draw line is run at full capacity as most of the scale is removed in the first furnace.

The last three furnaces are operated at about 100 F above the desired draw temperature. The pipe temperature increases slowly in these last three furnaces and leaves the section at the desired draw temperature. The process operator makes periodic checks with temperature sticks on the pipe leaving the last furnace to make sure the desired draw temperature is being obtained. These crayons melt at different temperatures and can be obtained in 50 F intervals in the draw temperature range. If a draw temperature of 1125 F is desired, the pipe is marked with an 1100 and 1150 F crayon. If the 1100 F crayon mark melts and the 1150 F one does not, the pipe temperature is considered satisfactory. Control of hardness and physical properties by this method has been very satisfactory.

TABLE I

Furnace	Temperature	Furnace condition
1	2220 F	Wide open
2	2250 F	Wide open
3	2300 F	Wide open
4	2250 F	Throttled and controlling
5	1950 F	Throttled and controlling
6	1600 F	Throttled and controlling

Since the pipe travels through the 32½-ft furnace sections at 5 to 10 fpm for the common sizes processed, the total time that any one portion of the pipe is in a section is only from 3.25 to 6.5 min. This means that the pipe has practically no time at temperature in the draw line. Satisfactory tempering is accomplished by this short time draw treatment on the plain carbon manganese steel used since it tempers rapidly. No difficulty has been encountered in obtaining uniform physical properties.

TABLE II

Furnace	Temperature	Furnace condition
7	2100 F	Throttled and controlling
8	2250 F	Wide open
9	1525 F	Throttled and controlling
10–12	1250 F	Throttled and controlling

QUENCHING EQUIPMENT

After the pipe is heated to an austenitizing temperature of about 1600 F, it passes through a quenching head located 2½ ft beyond the last furnace where it is water quenched cold.

Figure 6 is a view of the quench section of the heat treating line showing the furnaces, quench head, pump and filters. Water from a sump located in the foreground of Figure 6 is delivered through 2 self-cleaning filters mounted in parallel to an annular orifice quench head by a 1200 gpm centrifugal pump. Water pressure in the head can be adjusted with a gate valve in the main line to hold a constant pressure setting. Usually

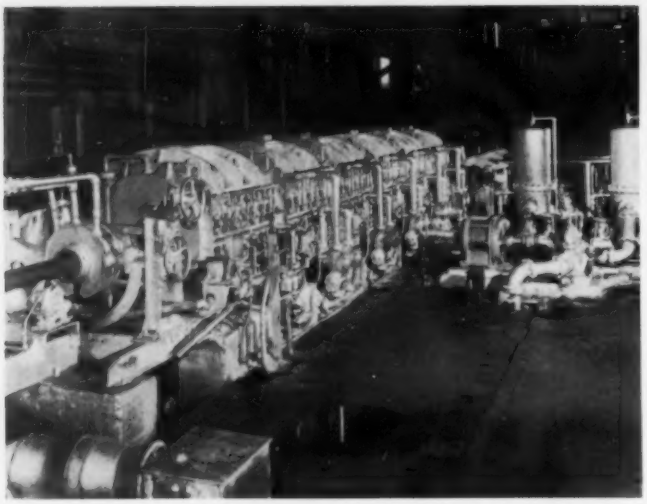


Figure 6 — Quench section of heat treating line. Pumping equipment is also shown.

a pressure of 30 psi is maintained in the quench head. The quench water drains into sluices which carry it back into the sump for recirculation. All make-up water comes from that used in the furnace cooling jackets and conveyor rolls. During normal operation, the water in the sump reaches a temperature of 105–115 F and remains constant. The self-cleaning filters have screen openings of 0.020 and 0.025 in. These filters are purged for several minutes at the beginning of each operating turn to remove any sludge collected.

A sectional view of the type of quench head used is shown in Figure 7. Two sizes of quench heads are used. The larger one has a 15-in. diam orifice and is used to quench pipe 7-in. outside diam and over. The smaller head has a 9-in. diam orifice and is used for sizes under 7 in. The annular orifice delivers a uniform cone of water at an angle of 30 degrees with the pipe axis. The larger head is operated with an orifice opening of 0.075 in. and the smaller head with an opening of 0.065 in. Using a smaller head to quench the smaller sizes of pipe produces a more uniform and effective quench. Keeping the distance from the orifice to the pipe surface short results in higher water velocity and less scatter and fanning out of the cone of water.

The pipe are quenched with 18-in. spacing between lengths. This spacing is necessary to prevent water from being splashed into the open end of a following pipe when the rear end of the preceding pipe goes through the quench head.

The water is delivered to the quench head from a manifold by three 2-in. pipe entering at the top, two of which are directed tangentially and one radially. When water is being delivered by all three pipe, the head throws a cone of water, all elements of which are directed toward a common vertex. When there is no pipe being quenched in this cone of water, a considerable splash-back occurs which will go into the front end of the next pipe entering the quench. This splash-back is eliminated by closing the valve on one of the tangential lines during the space between consecutive pipe. The cone of water begins to swirl and an open vortex is formed. A pneumatically operated valve which is controlled by a timer and a limit switch mounted at the quench head, opens and closes one of the tangential lines as each pipe enters and leaves the head. It would not be satisfactory to quench pipe with the one line closed as the swirling water greatly reduces the effectiveness of the quench.

By using the 18-in. spacing between pieces and the operation of the pneumatically controlled off-and-on valves, no water gets into the open end of the incoming pipe.

A ring pipe guide is mounted on the inlet side of the quench head to keep the pipe centered in the head while being quenched. This guide is very necessary to keep the pipe reasonably straight. If the pipe is allowed to move out of the center of the quench cone, the cooling conditions are not uniform and the pipe becomes increasingly crooked. A ring guide having ⅜ in. clearance is used for each size of pipe processed.

A laboratory study was made on the production quench heads to determine the approximate severity of quench being obtained. The study found the severity to be an H value of 3 to 5, which is a very effective quench. A number of experiments on the production equipment had determined that the maximum wall thickness that could be fully hardened using a 0.30 to 0.40 per cent carbon, 0.60 to 0.90 manganese steel was about ⅜ in. Similar steel quenched in a laboratory apparatus under conditions approaching an ideal quench also showed a limiting thickness of ⅜ in. for full hardening. Since the depth of hardening which could be obtained in a particular grade of steel was found to be practically the same by the laboratory method and the production quench head, it was decided unnecessary to do any more work toward developing a more effective quench head.

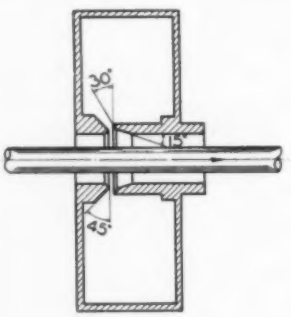


Figure 7 — Two sizes of quench heads are used.

Metallurgically, the finished microstructure of the N-80 material is tempered martensite. When the wall thickness is no heavier than about ⅜ in., the wall is fully hardened. In thicknesses above this, the inner portion consists of a mixture of tempered martensite and fine pearlite. The maximum wall thickness processed is 0.453 in. Since 90 per cent of the N-80 threaded and coupled casing made has wall thicknesses less than this, there is no need to change to a steel having greater hardenability. This small amount of casing and the coupling stock that is not made by quenching and drawing is made from the regular manganese-molybdenum steel.

PRODUCTION RATES

Normal production rates for some of the casing sizes processed in the continuous heat treating line are shown in Table III. These figures are for regular non-upset casing with an average length of 34 ft uncropped.

MAINTENANCE

No particularly troublesome maintenance problems have arisen concerning the operation of this heat treating line. Maintenance of the furnaces compares favorably with normal furnace types. As would be expected, most of the furnace repair work is confined to the lead furnaces in each section. These furnaces operate continuously at temperatures of 2100 to 2300 F. Scale impingement on the burner cups of the first draw furnace causes the most serious damage in the draw line.

Ceramic burner tips can be replaced if necessary while the furnace is in operation. The ceramic tip holders can be pulled and a new tip or an entire new assembly can be installed by shutting off only the gas to the one burner. It has been found that usually an inspection during the normal down time on week-ends is sufficient. After being down 16 hours, the furnace is cool enough that burner tips can be replaced from inside the furnace without removing the tip holders. The furnaces will heat satisfactorily even though 10 per cent of the burners are not operating normally.

Overhauling a furnace is relatively simple. The steel top including the fire brick comes off in one piece. The top and the end water jackets are set on the furnace proper with non-hardening cement. No damage is done to the brick when they are removed. So far the only major furnace parts that have been replaced are burner cups and burner walls and this has only been done on the lead furnaces.

Periodic inspection of the furnaces and control equipment is made by trained men of the combustion department. The carburetion units, fire checks and blow-out relief units are cleaned on a regular schedule. It has been found necessary to clean these units, especially the carburetors, every three months.

TABLE III

Size, in.	Weight per foot	Wall	Conveyor speed, fpm	Average tons per hr
5½	17	0.304	10.2	4.8
5½	20	0.361	9.3	5.1
5½	23	0.415	8.0	5.0
7	23	0.317	8.6	5.4
7	26	0.362	7.6	5.4
7	29	0.408	6.6	5.3
7	32	0.453	5.4	4.8
9⅝	40	0.395	5.0	5.4
9⅝	43.5	0.435	4.5	5.4

About once every six months it is necessary to disassemble the filters and thoroughly clean the filtering cartridges. The edges of the orifice in the quench head have been re-dressed several times to maintain a uniform jet of water.

DISCUSSION OF PRODUCTS HEAT TREATED

Practically all of the tonnage processed on this continuous heat treating line has been material to meet specifications of American Petroleum Institute Grade N-80 seamless steel casing. The physical properties required for Grade N-80 casing are given in Table IV.

TABLE IV

Minimum yield strength	80,000 psi
Minimum ultimate tensile strength	100,000 psi
Minimum elongation in 2 in. (strip specimens)	16 per cent

The only chemical requirements for this grade of seamless casing made of open-hearth steel are:

0.04 maximum per cent phosphorus
0.06 maximum per cent sulphur

To make a quenched and tempered Grade N-80 casing by the process described, steel in the analysis range given in Table V has been used:

TABLE V

Carbon	0.30-0.40 per cent
Manganese	0.60-0.90 per cent
Phosphorus	0.04 per cent maximum
Sulphur	0.05 per cent maximum
Silicon	0.25 per cent maximum

Using this analysis steel, all sizes of Grade N-80 threaded and coupled casing from 4½ through 9⅝ in. outside diam having wall thicknesses no heavier than 0.453 in., have been successfully produced by this continuous quenching and tempering process. A thorough study of the physical properties of this material has shown them to be equal to and in most cases superior to those properties of the commonly used normalized, or normalized and drawn high manganese-molybdenum casing. There have been no complaints from the oil fields concerning failure of the quenched and tempered casing to perform satisfactorily. The service history for the total production of over 7,000,000 feet has been very good.

Producing this quenched and drawn casing by the continuous process described was not accomplished without overcoming some very troublesome problems.

The major problem encountered was that of obtaining reasonably straight pipe after quenching. Crooked pipe after quenching is very difficult to handle through the remainder of the line, since it will not operate the control paddles properly, and will occasionally hang-up in the draw furnaces. Besides being troublesome in the heat treating line, crooked pipe produced in this process was exceedingly difficult to straighten later and it was usually found to be badly out of round. The crookedness consisted of twists and sharp kinks which were nearly impossible to remove by gag-press straightening.

The crookedness produced in quenching can be attributed to a number of causes such as:

1. Non-uniform heating before quenching.
2. Uneven quench due to quench head not functioning properly.
3. Uneven quench due to pipe not remaining centered in the quench head.
4. Eccentricity in the wall thickness of the pipe.
5. Pipe being crooked before heat treatment aggravates the situation during quenching.

Determination of the schedule of furnace temperatures in the quench section which gave the most uniform heating and skewing the conveyor rolls to rotate the pipe while being heated greatly improved the uniformity of heating. It was also necessary to skew the conveyor rolls in the draw section. Before this was done, the crookedness from quenching became worse during drawing.

Installation of pipe guides to keep the pipe centered in the quench head, increased pumping and filtering capacity, and the use of the air operated valve in one of the feed lines improved the effectiveness and uniformity of the quench.

Wall thickness eccentricity of the pipe was one factor that could not be eliminated as all seamless pipe is somewhat eccentric.

Since these various improvements were made, crookedness has been reduced to a point where it is no longer a serious problem. As would be expected, the straightness of the pipe varies directly with the diameter; the larger the pipe, the straighter it remains after quenching.

The following finishing operations are required to manufacture the quenched and tempered N-80 casing.

1. Preliminary rotary straightening.
2. Continuous quenching and tempering.
3. Rotary straightening.
4. Stress relieving and re-sizing.
5. Press straightening.
6. Check Brinell hardness of each length.
7. Cut off crop ends.
8. Thread.
9. Hydrostatic testing.

After quenching and tempering, the pipe is rotary straightened to remove the twists and kinks that are difficult and time-consuming to remove by press straightening. Rotary or roll straightening sets up internal stresses in the casing that reduce its collapse resistance. To remove these detrimental internal stresses, the casing is given a stress-relief re-draw in a roll-down heat treating furnace.

As the stress-relieved casing leaves the furnace, it passes through a three-stand sizing mill where it is re-sized hot, about 1050 F. During quenching, the transformation to martensite is accompanied by a growth of 0.030 to 0.040 in. on diam. In the early period of the operation of this continuous line, the pipe to be processed was rolled undersize by that amount and no resizing was done. At that time it was hoped that the pipe could be produced straight enough to be straightened by gag press only, thus eliminating the roll straightening and stress relieving. This condition was not reached where all pipe processed consistently came reasonably straight. Since roll straightening and stress relieving is necessary, it is just as economical to resize as the sizing equipment is available. No special size pipe needs to be rolled and the finished pipe diameter is within closer tolerances.

The material produced by this method is subjected to extensive tests during processing. Each length is Brinelled. A strip tensile test is made on each heat of steel processed. Rings for flattening tests are taken from 5 per cent of the pieces. All lengths are hydrostatically tested. During the development stage of making the quenched and tempered N-80, numerous supplementary tests were made such as hardness surveys across the wall, collapse tests, full section joint tests, slit ring internal stress tests, gun perforating tests, and microscopic examinations. At least one third of each heat of the first 5000 tons was magnetically inspected for the detection of quench cracks. No quench cracks were found and this inspection was discontinued. Also during the development stage, a hydrostatic test pressure of 6000 psi was used instead of the required 3000 psi.

Still in the development stage, another grade of casing having a minimum yield strength of 110,000 psi has been satisfactorily produced by quenching and tempering in the continuous line. This casing, which has upset ends, is for use in extremely deep oil wells which have depths to 20,000 ft or more. Prior to the current general unavailability of alloy steels containing nickel, casing to meet this severe application was made from normalized and drawn SAE-4340 steel. The quenched and tempered upset casing was quite successfully made using a boron treated, carbon manganese steel.

WHY THIS CHOICE OF EQUIPMENT

This particular equipment installed for the production of quenched and tempered casing was selected over other types of equipment that might do the job for several reasons. The overall floor space required is relatively small. The individually controlled radiant gas fired furnaces provide rapid heating combined with a high degree of control. Since the heating is rapid, about four to six minutes for most pipe sizes, little scale is formed on the pipe. The combustion products are maintained about neutral and the long sting-out due to the high pressure burners furnishes a protective atmosphere between furnaces. The absence of a heavy scale results in a more effective and uniform quenching.

An automatic continuous process produces material that is less subject to human error. Physical properties are quite uniform and are only varied by the chemistry of the steel used. The labor requirements are low; only two men needed to operate the entire line.

From a maintenance angle, the small furnaces are relatively simple to overhaul and the downtime is short.

During the five years this equipment has been in operation, numerous improvements have been made. Also, other features not included in the present setup are now known to be desirable. More furnaces, especially in the quench section, and provision for much greater pipe rotation during heating and quenching are two things that would improve the straightness and increase the capacity.

In conclusion, it can be stated that the process is a fully proven production method of manufacturing high strength quenched and tempered oil well casing from plain carbon steel.

DISCUSSION

PRESENTED BY

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A. B. Wilder: The authors have presented a clear description of the quench and temper process used in

the production of 80,000 psi and 110,000 psi minimum yield strength casing. The quench and temper process, as applied to the commercial production of large quantities of pipe, is a development which has received considerable attention during the past few years among the producers of oil well casing. In this development, one of the major problems encountered has been distortion of the pipe. This problem, as the authors have pointed out, has in a large measure been solved not only by rotation of the pipe during heat treatment but also by a sizing operation after heat treatment. In the production of oil country goods the product is usually threaded. This permits the use of steel in the higher strength grades with a greater hardenability than would be employed in ordinary grades of seamless pipe which are frequently girth welded.

Another new process which has been used for the production of over 31,000,000 ft of API N-80 casing and has resulted in a considerable saving of manganese and molybdenum is the warm-working process. The development of this process was the result of work carried out over the past forty years. Reid T. Stewart investigated the resistance of pipe to external pressure and in 1906 established an empirical formula for collapse resistance expressed as a function of the pipe dimensions. The resistance of pipe to external pressure is now known to also be a function of the transverse compression stress-strain curve of the material. It has been known for some time that the cold-working of steel pipe by various methods will often increase the collapse strength. API N-80 casing is being currently produced from carbon-manganese steels by a number of different cold-working processes. The amount of energy required to deform steel at a higher temperature is less, although the increase in the yield strength may be quite similar to that obtained when the work is conducted at ambient temperatures. In addition, when steel is worked at high temperatures, the material is stress relieved as it cools to ambient temperature, resulting in improved mechanical properties which are desirable for casing. These observations led to the development of the warm-working process.

In the warm-working process, the final reduction in size, ranging up to 8 per cent of the pipe diam, is made at a closely controlled temperature between the blue heat range and the lower critical temperature in a multiple-stand reducing mill. A carbon-manganese steel is used. The hot rolled pipe in this process, as it leaves the seamless mill, is heated in an equalizing furnace, warm-worked in a continuous sinking mill, and then delivered to the cooling tables. The result is casing with uniform high transverse compression and longitudinal tension mechanical properties. The increased transverse compression strength is associated with high collapse resistance and the increased longitudinal tensile strength with increased joint strength. The mechanical properties produced by warm-working are superior to those produced by cold reduction and subsequent aging treatments of carbon-manganese steels.

In the production of casing with a minimum yield strength of 110,000 psi, the National Tube division of United States Steel Co. explored a number of methods and, as a result, a quenched and tempered carbon-manganese steel was selected as providing very excellent toughness with satisfactory strength properties. Extensive tests of this material indicate that in addition to high collapse and tensile strength, the quenched and tempered casing has excellent elongation and impact properties. A significant tonnage of casing has been made with a minimum yield strength of 110,000 psi, an average ultimate strength of 139,000 psi, and an average elongation in 2 in. of 22.4 per cent in the tensile test. Perforating tests with the conventional method and the new jet gun resulted in perfect performance of this material. No cracks were observed although the shots were spaced very close together. Casing with 110,000 psi minimum yield strength is hydrostatically tested to 80 per cent of minimum yield strength up to a maximum of 12,000 psi. Information regarding the setting depth properties of this new casing is available.

In the manufacture of quenched and tempered casing with a minimum yield strength of 110,000 psi, the pipe is heated in a unit similar to the equipment described by Messrs. Bremmer and Zehnder. After austenitizing, the pipe is quenched with a specially designed water spray ring consisting of nozzles. Rotation of the pipe during heat treatment is employed to insure a uniform and straight product. The carbon-manganese steel employed is melted to coarse-grained practice to improve its hardenability with careful control of chemical limits. After quenching the pipe is tempered in a roll-down furnace and rounded up at the tempering temperature. Essential features of the quench and temper process for the successful manufacture of casing with 110,000 psi minimum yield strength are: (1) close control of steel melting practice, (2) uniform heating and rotation of the pipe during heat treatment, (3) uniform quenching, and (4) rounding-up to insure uniform dimensions and satisfactory collapse properties.

It may be of interest to point out that in the production of high strength line pipe with a minimum yield strength of 52,000 psi, an entirely different approach to the problem has been employed. A pipe line under pressure is subjected to longitudinal and transverse tension forces while casing is subjected to longitudinal tension and transverse compression forces. In addition, line pipe must be manufactured from a weldable grade of chemistry while casing is threaded and a higher carbon steel may be used. In order to improve the properties of line pipe the pipe industry employs a process which cold expands the pipe. This may be carried out by hydrostatic or mechanical methods. When line pipe is cold expanded, not only is the pipe sized, but the transverse yield strength in tension is increased. A high strength product can therefore be produced which not only meets the weldability requirements of the oil industry but, in addition, permits the use of higher operating pressures due to the nature of the mechanical properties.

M. S. Gettig: I think every one of us required to produce these casings or who has made any casing of higher strengths will realize and agree that the economical limit for the manufacture of these high strength casings by the use of alloys and the use of the so-called

dry heat treatments, has been reached. Furthermore, unless someone pulls a new rabbit out of a hat, we will all be forced into some type of liquid.

The idea of liquid quench and draw is not new. Some experiments were made as early as 1925 on quenching and tempering steel. These experiments consisted of heating the pipe which were about 20 ft long in an old coke fire, cold draw annealing furnace, and subsequently quenching the pipe in a horizontal cold water bath. This pipe was the old Grade C analysis, and to our chagrin, the pipe cracked from end to end. This indicates the severe stresses set up by the drastic quenching of the steel.

We then repeated these experiments but heated water to boiling temperature before the quench. In this case, no cracking occurred. I only mention these experiments at this point to bring out how severe the stresses are in the quenching operation and, also, to emphasize why crookedness results from quenching and tempering steel pipe. These same stresses are with us today.

The metallurgical aspects of liquid quenching and tempering are not at all complicated. However, the mechanics of controlling the stresses set up by the quenching and tempering do become very complicated and, as Mr. Bremmer pointed out, non-uniformity of draw and a number of other items greatly affect these stresses.

Our company as early as 1943 began to examine the possibilities of continuous quenching and tempering. At that time, in collaboration with one of the manufacturers of high frequency electric heating equipment and, also, in collaboration with one of the nationally known research organizations, we set up an experimental machine in Cleveland which was used for quenching only. We quenched quite a few pipe on that equipment, and it did very nicely except that the pipe cracked, of course, due to the stresses set up. We then superimposed a draw coil behind the quench head, and we heat treated, I would say roughly, 100 pieces of pipe with that mechanism. About 75 per cent of those pipes were commercially straight when we finished, and I am going to say at this point we rotated the pipe very rapidly. I feel that the rapid rotation was the most important single thing that helped in keeping the pipe straight. This pipe was of J-55 and N-80 analysis.

Quenching N-80 pipe which has about 0.45 per cent carbon and approximately 1.50 Mn is very difficult but we solved it by putting the coil immediately behind the quench head. In my opinion there would be more success from the quenching and tempering operations, if the draw coil, or if the draw furnace is placed immediately behind the quench, so that the time elapsing between the quench and the draw will be held to a minimum. In this way, the elasped time does not permit the stress time to do any damage before they are relieved. We feel at Youngstown that unless we can get 95 per cent straight pipe from the quench and draw furnace without the expensive and uneconomical subsequent treatments, the process cannot be considered satisfactory. For that reason, to date we have not as yet installed a quench and draw line.

In summarizing, I would like to bring out a few things which will deserve some further consideration. First, are there any other means of heating and quenching which will not set up the severe stresses which cause crookedness. I do not necessarily mean by that some process where pipe is quenched vertically, or other ideas on that order. I mean some practical method of heating and quenching to eliminate these stresses.

The second question, is there some other quench medium besides water which will give a slower quench, a more uniform quench, a less drastic quench, which would result in lower stresses being set up with resulting crookedness?

And third, should the draw line be placed in line with the heating and quench so that the stresses can be relieved before they become dangerous, or is there some other method of accomplishing the tempering which will not result in the one factor which is so far the greatest trouble; namely, crookedness.

I would be very happy to hear anything the author might have to say on those three problems.

F. H. Bremmer: Those are difficult problems which will take a long time to solve. I do not know the answers. I do know this, we picked our method after considerable experimentation, going back to I believe 1925 when we originally quenched and tempered drill pipe. I think we quenched from about 1925 to about 1932. This method was quite successful, but it was not the way to do it. We have run interrupted quenches with high rotation. We were not satisfied with these results either.

This is a process where we all have to get together, pool our knowledge, and one of these days we will come up with those answers that you are asking for. However, with our present knowledge, we feel that this method of heat treating is quite satisfactory, it has been stated in the comments by Mr. Wilder that straight pipe can be produced with proper rotation of the pipe during the heating and quenching operation.

Louis Moses: Can you further discuss the relative machining qualities, as found in the threading operation, between the product described and the alloy material which it displaces?

Another point would be to enlarge on the use of temperature sticks and what part they play in relation to the temperature recording instruments?

F. H. Bremmer: Concerning your first question, we feel that we can thread quenched and drawn casing at a higher hardness value, than we can thread our normalized and drawn casing. For equal hardness, the quench and drawn casing has better machining characteristics.

The last three furnaces in the draw line are operated about 100 F superheat above the steel temperature. As it is difficult to control the actual steel temperature under these conditions, we use temperature sticks to obtain the actual steel temperature. For example, if we desire a steel temperature of 1175 F, if the 1150 F stick melts and the 1200 F stick does not, we assume the steel temperature to be 1175 F.

With historical data available, we now use the sticks for check purposes on the temperature control system.

APPLICATION AND CONTROL OF A-C MOTORS ON INTERMITTENT LOADS

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. . . . much ingenuity is applied in designing a-c drives for intermittent loads to eliminate flywheels, to reduce variations in reactive kva, and to reduce violent load fluctuations . . . .

▲ ANY discussion of this subject must, of necessity, deal with simple and familiar principles which have been applied many times since the earliest days of rolling mill electrification. The basic principles are of course still good today, but changing conditions in the industry have shifted the angle of approach to the problem of handling intermittent rolling mill loads.

When electric power first began to play an important part in steel plant operation, only a small part of the total output was rolled in continuous mills. Most rolling mill loads were highly intermittent and power systems were isolated and of limited capacity. Flywheels were used quite freely to equalize the peaks, to eliminate mechanical and electrical shocks on the motors, and to reduce the capacity and cost of the electrical equipment. Little or no attention was given to fluctuations in voltage and reactive kva.

Under present conditions the tendency is to eliminate flywheels wherever possible. Plant average loads and system capacity have increased so much that the momentary kw peaks of individual mills are not such a serious problem. The increasing use of purchased power has, however, made it necessary to give more consideration to the elimination of wide variations in reactive kva. Of necessity, the utilities must consider how any intermittent load will affect their residential customers and their interconnections with other systems.

In the large plant it is usually sufficient to equalize only the most violent load fluctuations. Some types of tandem mills such as sheet mills and tinplate mills have wide variations in load, but the rate of change is slow. For such cases, automatic control of the excitation of the synchronous machines may be helpful in reducing voltage fluctuations. In plants of moderate capacity, consisting chiefly of electric furnaces and breakdown mills operating on purchased power, it may be necessary to do everything possible to reduce voltage variations in the surrounding area. It may be necessary to provide a special synchronous condenser for the arc furnace circuit, and it may be desirable to use flywheels on the breakdown mills. Between these two extremes the requirements will depend on local conditions.

Synchronous motors can be designed for practically any load which the power system can handle. They may be used for direct drive on constant speed applications, or they may be used to drive generators for supplying adjustable speed or reversing drives. However, before selecting a synchronous motor for either type of application, it is desirable to examine the inherent characteristics of a synchronous machine.

Curves for a typical direct drive are shown in Figure 1. The synchronous motor is rated at 3000 hp, 360 rpm, 100 per cent power factor, and is used to drive No. 3 roughing stand of a hot strip mill. The curves reproduced from an oscillogram, show the input for one complete pass requiring 98 per cent of motor capacity. The bottom curve shows the line current; the middle curve shows the field current; and the top curve shows the power input. An oscillograph was used to obtain an accurate record of the transient oscillations, which are too fast to be shown by standard indicating or graphic instruments.

The oscillations shown by the curves are a familiar inherent characteristic of any synchronous motor. They are due to the fact that the magnetic force which locks the rotor in synchronism with the rotating field of the stator, provides an elastic coupling rather than a solid coupling. When load is applied, the magnetic lines of force are stretched and the rotor poles lag a few degrees behind the stator field. So for every load, the rotor poles assume a definite position with respect to the stator field, and then continue to revolve in synchronism with the stator field. If the load is applied gradually, the rotor assumes its position without oscillation.

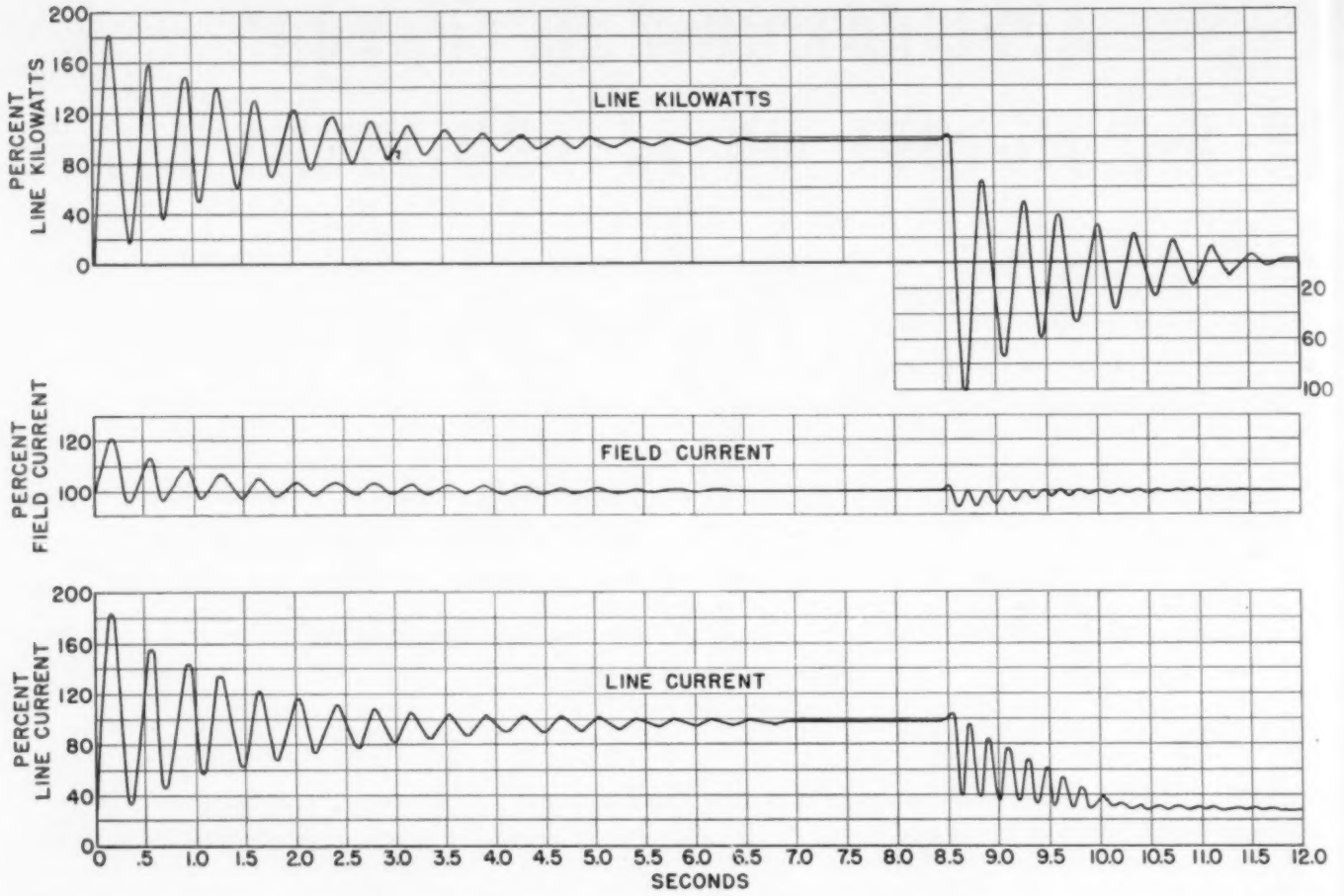


Figure 1 — Curves, as recorded on an oscillograph, depict the input for one complete pass requiring 98 per cent motor capacity.

If the load is applied suddenly, mechanical oscillations are set up which in turn produce the electrical oscillations shown in the curves.

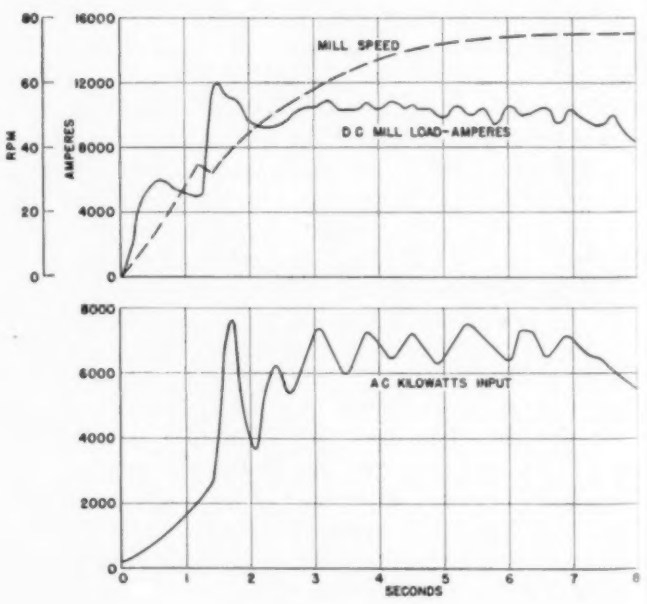
The period of the oscillations and the magnitude are determined by the design constants of the motor. For this particular motor the oscillations of current and power occur at regular intervals of 22-½ cycles when load is applied. When the load is released, the oscillations of current come at intervals of 11-¼ cycles, but the period of power oscillation is 22-½ cycles, since alternate swings are regenerative. The first swing of current and power is 184 per cent of motor rating, or 188 per cent of the final steady load. This ratio is the same for all loads for this particular motor. That is, for 200 per cent steady load, the first swing would be 376 per cent.

At no time during the period of oscillation is there any chance of the motor pulling out of step, if the load is steady, and if it is within the sustained pullout capacity. This is because the transient pullout torque is greatly in excess of the sustained pullout. However, if the loads are of short duration, and the timing is synchronized with the natural period of oscillation, the oscillations can become so violent that the motor will fall out of synchronism and stop.

The oscillations as shown are too rapid to be seen on ordinary indicating or graphic instruments. However, on extremely wide fluctuations, the protective relays may be affected, and special adjustments may be required to prevent the motor from being tripped off.

When a synchronous motor generator is used to supply d-c power for adjustable speed or reversing drives, there is a possibility for some cushioning action be-

Figure 2 — Beam enters mill at half base speed of the main motor, limiting the initial rise in the a-c load to 7700 kw.



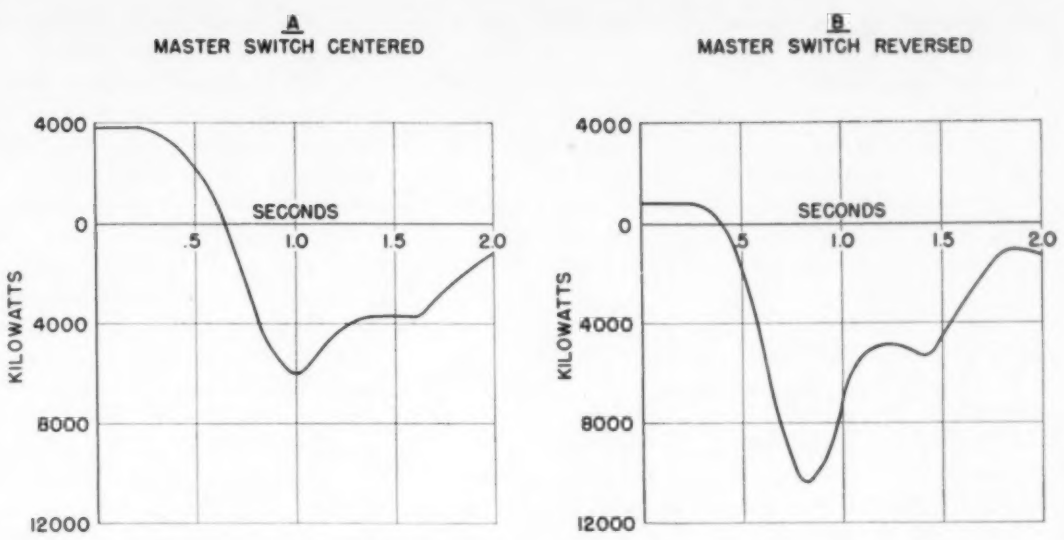
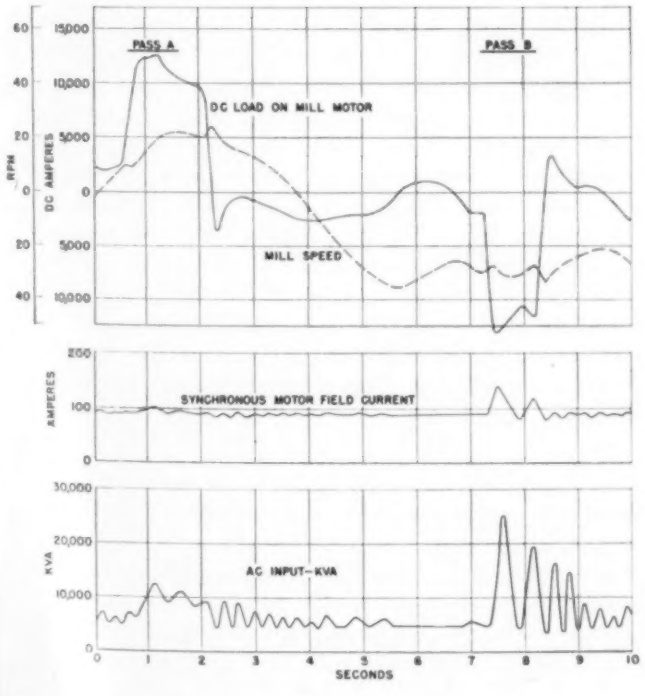


Figure 3 — The combined inertia of the two mill motors causes pronounced regenerative peaks during reversal of the mill.

tween the load and the a-c line. Whether this effect is actually obtained depends entirely on the manner of operation. The curves of Figures 2, 3 and 4 show some of the conditions found in actual operation.

Figure 2 shows typical curves for one pass in an intermediate beam mill. The main universal stand is driven by a 6000-hp, 60/120-rpm reversing motor, and the edging stand has a 2000-hp, 75/225-rpm reversing motor. Power is supplied by a 6000-kw synchronous motor generator, having an 8500-hp, 90 per cent power factor, 375-rpm synchronous motor. A-c power comes from a large 25-cycle system which is affected more by power swings than by variations in reactive kva. The 8500-hp synchronous motor operates with fixed excitation. A synchronous set was chosen because of the length of the passes.

Figure 4 — Reproduced oscillogram taken of two successive passes on a reversing plate mill drive shows the speed and armature current for the reversing motor, and the corresponding a-c input to the motor generator and transformer is shown in the bottom curve. The middle curve shows field current for synchronous motor.



The total current for both mill motors and the speed of the 6000-hp main motor are shown at the top of the figure. The bottom curve shows the a-c input to the set in kw. The beam entered the mill at about half base speed of the main motor which corresponds to half voltage on the generators. This, and the fact that the load comes on in two steps, limited the initial rise in a-c load to 7700 kw, which is only slightly above the average load. If the pass had started at full d-c voltage, the initial peak would have been about 15,000 kw.

Since there are two mill motors with considerable combined inertia, the regenerative peaks during reversal of this mill are quite pronounced. Typical examples are shown in Figure 3. Curve A shows the change in a-c load at the end of a pass when the master switch was centered, and the mill allowed to drift to rest. In ¾ sec the load changed from 3800 kw motoring to 5800 kw regenerative. When the idle mill is reversed from top speed, there is total change in load of 11,200 kw in ½ sec, as seen in Curve B. More rapid reversal of a single motor with less inertia, but with the latest type of control, could cause peaks of about the same magnitude.

This equipment has been in operation since 1930. It has been found that the reverse power peaks have been the principal source of disturbances to the plant system. However, such disturbances are noticeable only when the plant load is light and not all the generating units are in service.

Figure 4 is a reproduction of an oscillogram taken on a reversing plate mill drive. Two successive passes are shown, one in each direction of travel. The mill is driven by a reversing motor rated at 5000 hp, 30/60 rpm. D-c power is supplied by a 4000-kw motor-generator having a 6500-hp, 514-rpm, 80 per cent power factor, 6300-kva synchronous motor. No attempt is made to regulate the excitation of the synchronous motor. A-c power comes from a large power system through an independent 6500-kva transformer having 8 per cent impedance. This system is affected more by variations in kva than by changes in power load. A total of five of these units

are in operation in this country—all on large power systems.

The curves at the top of the figure show the speed and armature current for the reversing motor, and indicate the nature of the mill load. The corresponding a-c input to the motor-generator and transformer in kva is shown by the curve at the bottom of the figure. The middle curve shows the field current for the synchronous motor. All values are plotted against time in sec.

For Pass A, the entry speed was only 10 rpm, corresponding to about ⅓ voltage, and the a-c input was limited to 12,500 kva. For Pass B, the peak d-c current was practically the same as for Pass A. However, the pass was entered at 30 rpm with full voltage on the generators, so the maximum a-c load was 25,500 kva. These two examples show how much the a-c load depends on the manner of operation.

These examples will serve to show the factors which must be taken into account in determining whether synchrouous apparatus can be used for a given application. If power is to be supplied from an isolated system, the effects of swings of both power and kva are important considerations. If power comes from an interconnected system, the variations in kva may be the most important factor.

For installations where it is necessary to equalize the peak loads, three general methods of control have been used. The method used for single speed drives is shown in Figure 5. This is the familiar combination of a wound rotor induction motor, flywheel and permanent slip resistor, or slip regulator. Magnetic control with permanent slip resistance has been used with motors up to 7000-hp capacity. However, the development and improvement of the slip regulator has made the magnetic starter obsolete for flywheel applications requiring motors larger than about 750 hp.

Figure 5 — A wound rotor induction motor, with flywheel application and slip regulator, is employed to equalize the peak loads on a single speed drive.

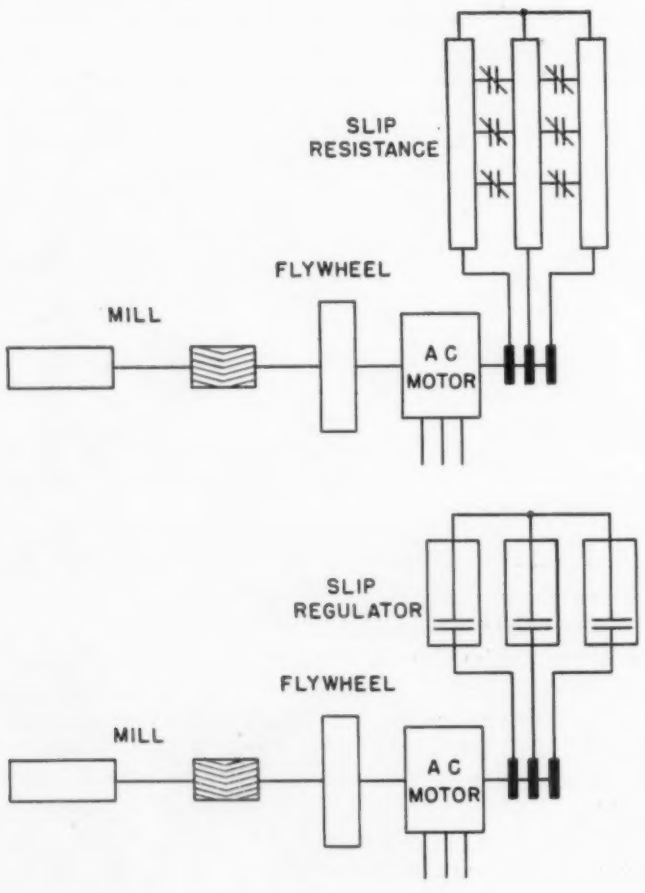


Figure 6 shows the advantages of the slip regulator. The solid lines in this figure show the input and speed for a wound rotor motor with flywheel and permanent slip resistance during a pass which requires 200 per cent of rated motor torque. The flywheel effect has been assumed as 20 hp-sec at synchronous speed per rated hp, and the total slip has been assumed to be 10 per cent at full load. It has been assumed that the end of the pass came just as the input reached 150 per cent of motor rating. The speed at this point is 85 per cent of synchronous speed.

The broken lines show the input and speed for the same motor with a slip regulator set to limit the input to 125 per cent of capacity. Flywheel effect and length of metal rolled are the same as for the motor with slip resistance. It will be noted that the input rises in about one sec to the 125 per cent regulator setting, and continues at this value after the end of the pass until the regulator plates have again reached minimum separation. The slip regulator allows more energy to be supplied to the motor in a given time, so the speed does not drop as much, and the recovery is faster. In this example the speed drop with the regulator is 11.3 per cent, as compared to 15 per cent with the slip resistance. The net result is a higher average speed for the motor with the slip regulator, or longer passes for the same drop in speed. An article by Mr. J. W. Deimler in the Iron and Steel Engineer for October 1951, gives a practical example of this difference in performance. By replacing a permanent slip resistance with a slip regulator, it was possible for a small plate mill to roll longer plates with lower peak loads.

For unusually long passes the slip resistor and the slip regulator have entirely different characteristics. With the slip resistor the motor load will rise until the motor torque eventually is equal to the load torque. The speed will fall to a point equal to one, minus the product of the per cent load, times the per cent slip, and will continue at this value to the end of the pass. With the slip regulator, the motor input will remain at the regulator setting throughout the pass, but the speed will continue to fall throughout the duration of the pass. If the pass is sufficiently long, the motor will stop. For such unusual conditions an induction motor and flywheel are, of course, not suitable, and a synchronous motor should be used.

Figure 7 shows an arrangement which is sometimes used for adjustable speed drives of moderate speed range for roughing mills. The d-c motor can be made to have a drooping speed characteristic either by using a series exciter or a current limit regulator. With a series exciter, the load on the a-c line is similar to that shown in Figure 5 for a wound rotor motor with a flywheel and permanent slip resistance. If a current regulator is used,

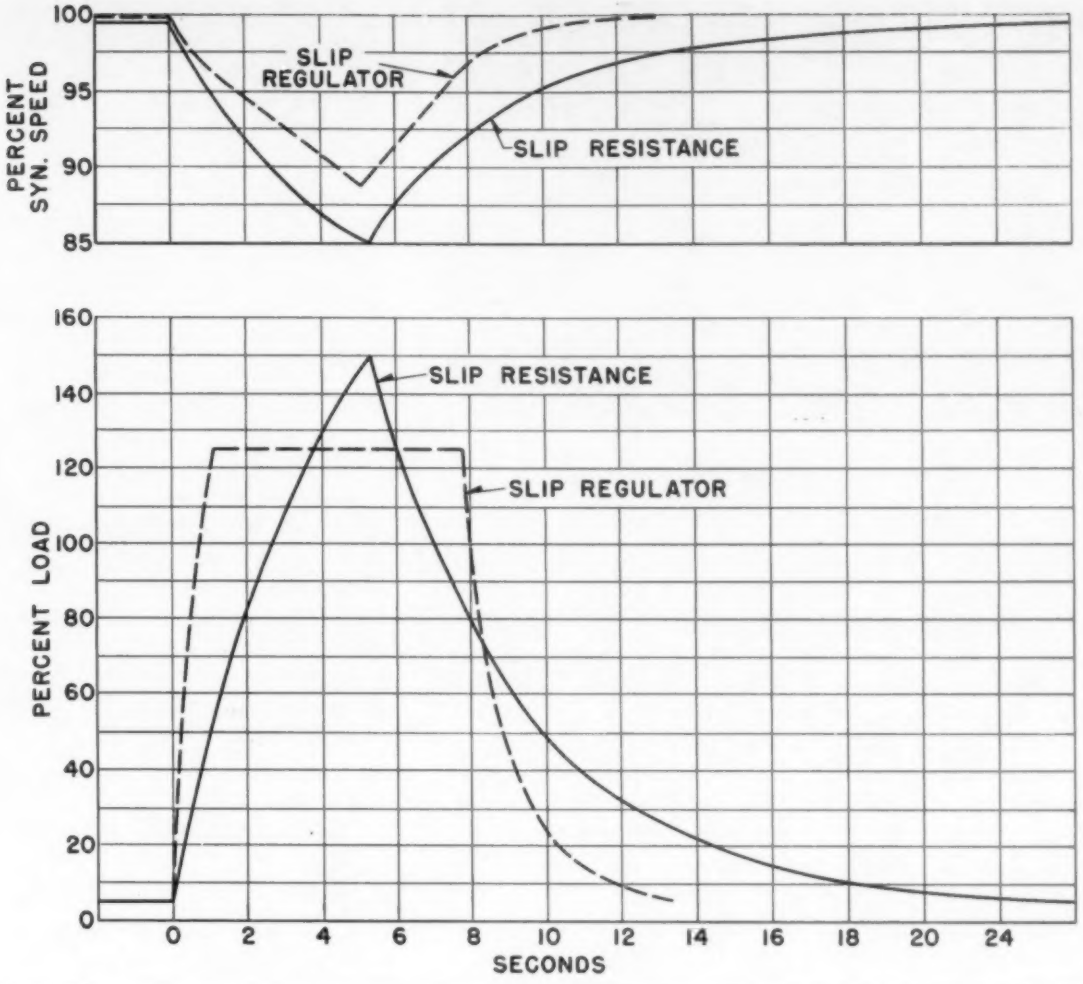


Figure 6 — Use of the slip regulator results in a speed drop of 11.3 per cent, compared with 15 per cent with a slip resistance. Motors with slip regulators average higher speeds, or maintain longer passes for the same drop in speed.

the a-c load will be similar to that for a wound rotor motor, flywheel, and slip regulator. This system is useful for roughing mill drives of moderate capacity which are supplied from a small power system. By proper selection of flywheel effect the capacity and cost of the electrical equipment can be reduced. This system has no slip losses.

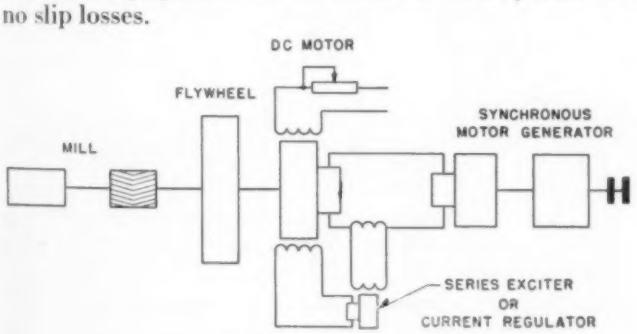


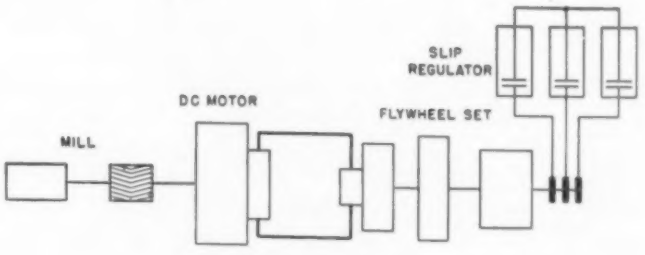
Figure 7 — D-c motor with a series exciter or current regulator, causing a drooping speed characteristic, is used for adjusting speed drives of moderate speed range for roughing mill.

Figure 8 is the conventional diagram for reversing mill drives for heavy service. The liquid slip regulator serves as a means for starting the flywheel set, regulating the a-c input during operation, and for absorbing the stored energy during dynamic braking. The standard flywheel set has at least 50 per cent more flywheel effect than is generally used for a-c mill drives. This makes it possible to handle a wide range of mill loads with the regulator set at not more than 125 per cent of the rating of the induction motor. The average slip is usually five to seven per cent, and the maximum momentary slip need not exceed 10 to 12 per cent.

By means of special regulating equipment similar to that used for a-c adjustable speed drives, it is possible to recover part of the slip losses incurred in regulating by secondary resistance. However, the saving in energy will not justify the cost and complication of the additional apparatus.

The liquid slip regulator was used with flywheel sets and a-c rolling mill drives as early as 1913. It is still the most satisfactory device for this type of service. The principal shortcomings of the early models were the weight and bulk, the inefficiency of the cooling system,

Figure 8 — Conventional schematic diagram used for reversing mill drives in heavy service.



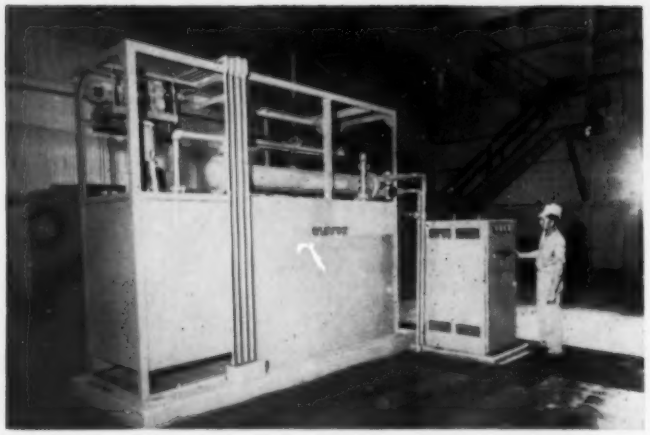
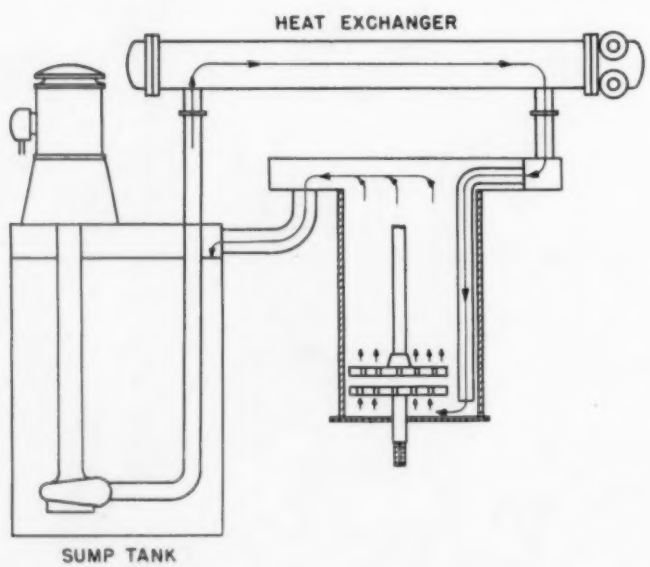


Figure 9 — New type liquid slip regulator is available in four sizes for motor ratings up to 10,000 hp.

and the limited capacity of the electrodes. All of these limitations are due to heat transfer by convection.

A completely new design has been developed to overcome the limitations of the older types. One of the new regulators is shown in Figure 9. This regulator is used with a 6000-hp wound rotor motor on a flywheel, set for a reversing plate mill. The design incorporates a number of new features. The electrodes are not submerged in a common tank, but are located in three separate circular cells which are made of asbestos cement, impregnated with tung oil. The cells are connected at the top to a common overflow chamber. Most of the electrolyte is contained in a separate sump tank. A motor-driven, vertical pump continuously circulates the electrolyte between the sump tank and the cells. A heat exchanger located at the top of the main structure cools the electrolyte. The moving electrode assembly is actuated by a motor driven winch. The control and a small motor-generator for supplying the winch motor are located in a separate control cabinet. This design is available in four sizes for motor ratings up to 10,000 hp.

Figure 10 — Circulating system for the regulator is based on long experience with water rheostats for large wind tunnels.



The circulating system is shown schematically in Figure 10. The circulating pump, with its stainless steel drive shaft, is located at the bottom of the sump tank. Warm electrolyte drawn from the sump tank is forced through the heat exchanger into a header at the top of the regulator. Tubes extending down from the header deliver cool electrolyte to the bottom of the electrode cells and force it upward through openings in the electrodes. The heated electrolyte rises to the top of the cells and flows back to the sump tank. This circulating system is based on years of experience with water rheostats for large wind tunnel drives.

The heat exchanger has stainless steel tubes to insure long life. It is designed to remove the normal heat losses with a moderate difference between the temperatures of the cooling water and the electrolyte. In starting a motor and flywheel from rest, there is at first little or no temperature difference, so for a few seconds the thermal storage capacity of the electrolyte absorbs all the starting losses. As the temperature rises the heat exchanger becomes increasingly effective. The maximum temperature of the electrolyte in the sump tank is thus limited to 130 to 150 F. After the motor is up to speed the temperature falls rapidly to the normal operating value.

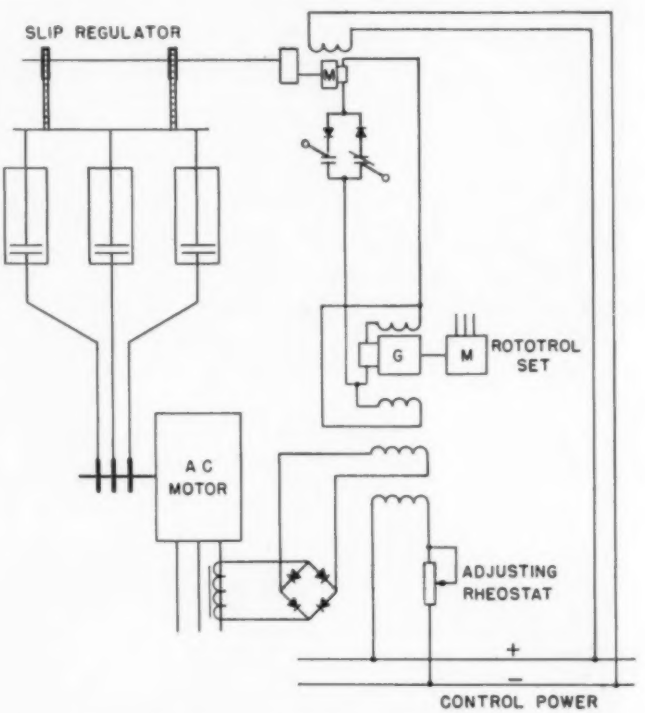


Figure 11 — The moving electrode assembly is completely counterbalanced; travel is actuated in both directions by a motor-driven winch.

A schematic diagram of the electrical connections is shown in Figure 11. The moving electrode assembly is completely counterbalanced, and is actuated in both directions of travel by a motor-driven winch. The winch motor is supplied from a rotating regulator generator which has two external sources of excitation. The regulating field receives excitation from a current transformer and rectifier, which is proportional to the current input to the induction motor. The differentially-connected reference field is excited from a con-

stant potential source, and the adjustment of its excitation determines the setting of the regulator. When the motor load exceeds the setting, the excitation of the regulating field predominates, and the rotating regulator will supply power to the winch motor to separate the electrodes and restore the balance. When the load falls below the regulator setting, the unbalance produces a rotating regulator voltage that will bring the electrodes together. A limit switch stops the winch motor when the electrodes have reached the point of minimum separation. When this limit switch is open, a dry type rectifier connected across its contacts insures that the winch motor will be responsive only to voltage in a direction which will again separate the electrodes. A similar limit switch functions in the same way at the upper limit of travel, except that in this position the winch motor can move only to lower the movable electrodes. When the electrodes are separated slightly and the load is being regulated, both limit switches are closed.

In conclusion, certain types of a-c loads probably will require special attention for some time to come. It is hoped that the information given in this paper will assist in the solution of future problems.

DISCUSSION

PRESENTED BY

D. C. McCRADY, Electrical Engineer, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

H. N. SNIVELY, Design Engineer, D-C Motors and Generators, General Electric Co., Schenectady, N. Y.

H. H. ANGEL, Electrical Engineer, Bethlehem Steel Co., Bethlehem, Pa.

T. B. MONTGOMERY, Engineer-in-Charge, Control Design, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

R. H. WRIGHT, Industry Engineering Department, Westinghouse Electric Corp., East Pittsburgh, Pa.

D. C. McCrady: Mr. Wright has given an excellent presentation of the problems involved in using synchronous and slip ring motors on loads of a peaking nature. The losses in slip regulators are so fantastically large, and the costs and complication of wound rotor motors themselves are so great, that any means for using synchronous motors would most definitely be welcome to the steel industry.

The scheme for using a d-c motor with a flywheel supplied by a synchronous motor-generator set is an interesting application. However, the question immediately arises as to whether there is any possibility of using some form of reactive kva regulation on a synchronous motor driving a motor-generator set for a reversing mill. In other words, is it conceivably possible to force a synchronous motor field at a sufficiently rapid rate to take care of peak loads to, at least, some moderate extent. The signal for any such regulator would, of course, have to be taken from the d-c loading and voltage, providing extremely high leading reactive kva at the time of high power peaks, thereby maintaining the system voltage under heavy load conditions. In order to force the field at a sufficiently rapid rate, presumably the synchronous motor would have to have some sort of special design, and no doubt be considerably oversized. However, the saving in the cost of power over the years would be well worth the extra cost, if indeed the cost were greater than that of the normally expensive slip ring motor and liquid regulator.

As far as slip regulators themselves are concerned, the new design which Mr. Wright has mentioned certainly looks to have considerable advantages over the conventional type.

H. N. Snively: The author presents a problem which may not be overlooked—the possible serious disturbances to system voltage, frequency, and power factor, caused by intermittent loads. It is timely because more and more, as Mr. Wright pointed out, applications of large synchronous motors are being made directly to mill drives and to motor-generator sets powering direct current drives, where intermittent loads of the type discussed are characteristic typical of such recent installations are reversing hot strip mills, blooming and slabbing mills and seamless tube piercing mills.

We agree with Mr. Wright that line kilowatt swings, and other oscillations such as he described, are typical with synchronous motor drives. We feel, though, that we should not forget that there are many synchronous motor installations in this category that have given many years of successful performance. Some of these motors are on small, "soft" power systems, while others are on large, "stiff" systems, and we know of no serious complaints on any of them.

Since the economy of operation, ability to control reactive kva, lower first cost, and lower installation cost of synchronous motor drives is so attractive, it behooves all of us to examine carefully the possibilities of using synchronous motor drives before we go to the more expensive and less efficient induction motor drives.

H. H. Angel: I am certain that many of us may not have realized the magnitude of the transient oscillations on synchronous motor drives. A number of years ago, the peaks from six large synchronous motors operating the roughing stands and the 600-v motor-generator sets of a hot strip mill, caused the power company a considerable amount of embarrassment and worry, especially since the synchronous fields lacked automatic control. It was essential to maintain very strong fields on the roughing mill motors. As the power system expanded, the disturbances were less noticeable.

Recently, in a 68-in. hot strip mill, the standard graphic wattmeter on No. two rougher motor, rated 3500 hp at 80 per cent power factor, was operated at high speed for a few minutes. The peak load was about 3900 kw for approximately four sec while rolling 61.25 in. width slabs. Slow speed charts showed peaks beyond full scale, which are estimated at least 4500 kw. This is about 160 per cent load.

No. 5 rougher motor, rated 4500 hp, 80 per cent power factor, 350 per cent pull out torque, showed seven sec peaks of at least 8000 kw. This would repre-

sent at least 220 per cent load. If we were to take Mr. Wright's figure of 184 per cent which applied to a specific motor only, then the first oscillation might be around 14,700 kws. Of course you must also add to that the oscillations from the other synchronous motor drives.

The author gave some sizes of generators and synchronous motors on the motor-generator sets of reversing mills. A rough comparison between the size of these synchronous motors and those on wound rotor motors driving the same size generators, with which I am familiar, indicates that the synchronous motors are about sixty to seventy per cent larger in capacity than the corresponding wound rotor motors.

I would like to ask Mr. Wright what size comparison is generally used.

T. B. Montgomery: One of the principal factors of importance in Mr. Wright's paper are the test results. If we can back up application theory with test results, it certainly gives us a peace of mind and assurance that we do not have otherwise.

Could I suggest that, particularly on your reversing mills with the peaks you show, if the WK^2 values are available, they would add to the value of the paper as a reference.

These liquid rheostats are an old device that have been revived, certainly from our point of view, because of the competition of the liquid coupling. On the smaller applications, it has been rather surprising what can be done, particularly in the range of speed obtainable. There are two general applications, one is for power plant auxiliaries and the other on these heavy drives.

We have a number of installations in power plants with speed range of eight per cent. That is done by configuration of the electrodes, and you can quite conveniently get equal rpm per in. of electrode movement.

In the larger sizes, the question of reliability in continuous service may arise. Outage of the pump for circulating the electrolyte is the chief item in this consideration. It is quite convenient to add an overhead tank to these rheostats, so that if the pump shuts down, electrolyte flow continues by gravity.

Although the liquid rheostat is a very old device, renewed interest in it makes it seem now that we should have thought about the possibilities of making it a more useful device years ago.

R. H. Wright: In presenting this paper it was not the intention to discourage the use of synchronous motors for intermittent loads. It was the intention by presentation of test curves made under actual rolling conditions, to provide information for more intelligent application of synchronous drives. Test curves of transient conditions are always more valuable than calculated curves, because it is difficult to make proper allowance for all the variables which should be considered in making calculations.

To answer Mr. Angel's question—the continuous rating of the synchronous motor for a motor-generator used to supply a reversing motor is the same as if the d-c load were continuous. For example, a 7000-kw synchronous set for an 8000-hp reversing mill drive would have a 10,000-hp driving motor with a 300 per cent pullout torque. A synchronous motor selected on this basis has ample capacity because a part of the rolling is done at low speed and reduced voltage. The standard wound rotor motor for a flywheel set of the same rating is 6000 hp, and the pullout torque is not a serious consideration, although 250 per cent is usually provided.

Mr. Montgomery has raised an interesting question regarding the effect of inertia on the transient peaks of a synchronous motor. A number of factors, including the inertia of the motor and its load, determine what goes on during the oscillation periods. The principal factors are electrical in nature. It is possible by design to effect some control over the damping factor which determines the number of oscillations in the transient periods. However, this has very little effect on the first load swing. For reversing mill drives, the inertia of the d-c motor and mill has no effect on the a-c load, except during reverse power peaks.

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THE EXTRUSION OF STEEL — EQUIPMENT, OPERATION, PRODUCTION

By JACQUES SEJOURNET*
General Manager
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Paris, France

. . . . one of the newest advances in steel production techniques is the extrusion process for steel shapes . . . .

▲ IT is the purpose of this paper to present to those interested primarily in the engineering aspects of steelmaking and steel processing, the underlying principles of successful extrusion of steel, the novel means of accomplishment now in use, and some possible future departures from present practices. As a matter of convenience, the presentation is divided into three major phases: the equipment, the operations, and the rates of production, which latter largely determine costs.

I — EQUIPMENT

A. Old presses employed in bringing the process to realization — The combination of all the completed experiments and the practical operations that have been undertaken in the field of extrusion during the past few years has substantially modified the ideas previously existing with respect to the apparatus to be employed.

The first press used for such experiments and for the development of a practical process for steel extrusion was installed in Paris in a small workshop of Comptoir Industriel d'Etirage et Profilage de Metaux (C.I.E.P.M.). It was a 600-metric ton press made in France and was quite old; it had been designed for the extrusion of non-ferrous metals.

From the very beginning of the tests, it appeared necessary to effect great changes in this press in order to obtain results that could be commercially valuable. Certain basic differences appeared when comparing steel extrusion with that of the non-ferrous metals:

1. The pushing out of the discard demanded considerably greater force.
2. The sawing of the discard required much more power than that needed for the non-ferrous metals, particularly when dealing with highly-alloyed steels.
3. The time of contact between the hot bar and the tools needed to be reduced to a minimum.
4. The contact between the container and the die posed problems that were completely new.
5. The extrusion speeds had to be very greatly increased.

Other modifications were made toward easing various operating conditions: reduction of the time required per cycle, simplification of tool changes (dies, die-supports, containers, mandrels) and finally the installation of special devices for the reduction of time lost due to the action of auxiliaries, personnel, etc.

It should be stressed at this point that non-ferrous metals are expensive materials and in such cases the cost of conversion by extrusion is of small importance when compared with the value of the finished product. Extrusion presses used for these metals were designed on the basis of assured operating conditions, especially were they sturdily built in order to guarantee perfect and continuous operation.

With the exception of special types, steels are inexpensive metals which cannot carry high conversion costs. It appeared then that presses for the extrusion of steels, while definitely retaining the qualities of sturdiness and assured performance of their forbears, must additionally provide higher rates of production and possess all the features necessary to avoid breakdowns.

It was on the basis of these requirements that the first press specially designed for steel extrusion was ordered in France. It was a press of 1500-metric tons. However, due to great delays caused by the war and the economic conditions in France immediately following the war, this press ordered in 1942 was not placed in operation until 1949, which is merely saying that it was already out of date before it began to work.

This press, having been installed at Persan, was equipped with devices capable of satisfying the numerous operating requirements, thus permitting demonstra-

*Paper read by Jerome Strauss, Vice President, Vanadium Corp. of America.

tion of the special characteristics of the new technique. This press made it possible to attain very high extrusion speeds and to indicate the full significance of such high speeds.

In the course of the development it became evident, however, that some of the devices that had been applied to the Persan press were not required for successful commercial operation and could be eliminated. Consequently the design of the press was simplified and it became possible to set up an improved specification for future construction to be recommended for steel extrusion.

B. Presses in use for steel extrusion — Among the steel extrusion presses in operation throughout the world, or about to be placed in operation, three types may be distinguished:

1. *Presses for non-ferrous metals modified for the extrusion of steel.*

These presses are to be found in plants producing highly-alloyed steels of high value. The modifications made have been: (1) to secure the proper extrusion speed, (2) in the operations of detaching and sawing of the discard, and (3) in the movement of the container.

The original operating cycle has generally been maintained, thus remaining very long.

These presses are technically well equipped for the extrusion of steel but the number of strokes per hour remains small and the conversion cost is high. They are thus restricted to the conversion of expensive metals and are not recommended for common steels.

A study has been made recently by an English equipment builder who desired to rebuild a new non-ferrous metal press with the objective of adapting it to the extrusion of sections and tubes of plain carbon steel. This study has shown that it was more economical and faster to construct in its entirety a press suitable for steel rather than to undertake the modification of a press already available.

2. *Presses specially designed for the extrusion of steel.*

The general design of these presses stems from that of the older presses in respect to their conception, their sturdiness and their dependability.

The following problems, especially, have been studied and solved:

a. Container — The guides and fastenings of the container as well as its method of support, have been modified.

b. Sawing of discards — One or two powerful and automatic saws are indicated.

c. Operating procedure — The procedure is suitably carried out according to a recommended sequence of steps. This procedure can be simplified when dealing with rounds and tubes.

d. Extrusion speed — A special hydraulic system has been provided to permit the delivery of water under very high pressure without vibration of "water-hammer" caused by action of the ram. This speed can be controlled either at the start, or during the course of operation.

e. Supervision — Most of the operations are automatic and rapid: charging of the billet, setting of the dummy-block and of the mandrel, recovery of the block after use, and removal of the discard after sawing.

f. Auxiliary operations — Provision has been made for the automatic distribution of the vitreous lubricant, automatic cleaning of the container, and the automatic cooling of the stem and of the mandrel.

g. Changing tools — As the result of considerable study, dies may now be changed in a matter of seconds. The container and stem can be changed in less than an hour.

h. Operating troubles — New devices render it possible, in the case of certain difficulties, to eject the product being extruded so as not to stop production.

i. Run-out table — The run-out tables are roller-driven and allow for the automatic removal of the extruded bars.

j. Time cycle — Speeds of all auxiliary operations have been materially increased; approach and recoil of the stem, movement of the container, charging of the billet, movement of the die-support. The total cycle has thus been reduced to 30 seconds.

3. *New ideas on special presses for steel extrusion.*

It is not difficult to imagine that future designs will depart still further from those already greatly improved during the course of recent application.

It has been noted above that designers and operators will, of necessity, turn toward machines of high speed. However, the studies of the operating cycle have shown that an important part thereof is consumed by the movement of the slide-block along the axis of the press. One therefore visualizes the possibility of replacing this longitudinal movement by a transverse one and to further take advantage of this modification by designing a mechanism with which it will be possible to prepare and position another die during the time of the actual extrusion operation in order that, as soon as this operation ends, this die can instantly be set in place. A reduction of 20 to 30 per cent of the total operating cycle may thus be obtained.

Such installations are already being tried, one at Persan, the other in the United States. There is need for considerable study of their functioning inasmuch as placing them in production is a delicate matter, above all in order to insure satisfactory centering of the tools when extruding tubes.

C. Discussion of presses for the future — Before giving further details of the presses that may be employed in the future, there is need to stress one particular point common to most industrial equipment: a given extrusion press can produce economically only a limited range of products.

On a given press, it is actually possible to cover a very wide range of products but from an industrial or economic viewpoint it is not possible to operate in more than a small part of that range. To illustrate by a specific example, it may be stated that a press of 1500-metric tons equipped to produce sections in ordinary carbon steel can make such products, weighing between about 5 ounces and about 33 pounds per foot. Practically, the economic limits of the range are about 1 pound to 13 pounds per foot.

Conversely, to economically produce very large quantities of one particular section, would call for a press of a particular capacity, selected to obtain minimum unit cost and maximum production. Adequate formulae and extrusion constants are now known and confirmed by experience, to establish the specifications of the presses to be used for the various cases that may arise in actual practice.

It seems certain that in the future it will be necessary to distinguish between:

1. *Highly-alloyed steels or super-alloys* — These steels and alloys can be converted with only a low extrusion ratio. Thus when starting with billets of large diameter to obtain products of small section, it will be necessary to employ two successive operations. The tonnages to be produced being generally small, one must envisage an extrusion press equipped with an accumulator of variable pressure permitting adaptation of the working force to the diameter of the container used in each operation.

2. *Moderately-alloyed steels (stainless and heat-resistant)* — The presses will be used only at their nominal pressures and the range of their production will be limited to a field that will be economically interesting to exploit.

3. *Low-alloy and carbon steels* — It is necessary to envisage specialization of presses to obtain in this field acceptable conversion costs.

An initial absolute requirement is to avoid the use of the same presses to manufacture interchangeably, both sections and tubes. Presses for the production of sections are simpler, lighter for the same power, and less costly than presses to produce tubes; the operating cycle for the extrusion of sections is shorter than that for tubes. The production of sections on a press designed specially for sections will therefore provide excellent conversion costs, and particularly if it is possible to limit the products to those having a weight per foot close to that yielding the most favorable results on the press selected. As will be seen later, this at once implies the conversion of large tonnages.

Presses for the manufacture of tubes will be specially equipped for this purpose. Up to the present only presses with movable mandrels have been used for this work. Extrusion with fixed mandrels having conical points will probably result in improved performance by permitting standardization of the diameters of pierced holes, greater ease of reconditioning mandrels and increasing their service life.

It is necessary also to give consideration to vertical presses and to their great ease of handling.

Finally it will be requisite to utilize, whenever possible, reverse extrusion which reduces the starting force and thus reduces the power consumption.

D. Mechanical presses — For some time there has existed the question of the possible use of mechanical presses for steel extrusion.

Until now, the reply to that question was negative because lubrication with vitreous products required for its full effect complete control of the operating speed. Progress during the last few years has made it possible to produce lubricants permitting considerable broadening of the operating speed range. One may therefore look forward to the application of such presses to the extrusion of steel, but it must be said that there has yet been no experience in this field.

The advantages of mechanical presses over hydraulic presses will be the following:

1. Lower cost.
2. Shorter delivery time.
3. Higher operating rate.
4. Lower operating cost.
5. Possibility of complete mechanization of the operation.

The disadvantages are the following:

1. Variable working pressure.
2. Variable operating speed.
3. Difficulty of adjusting the stroke of the ram.

It is thus possible that mechanical presses may find application for *quantity production of single items.*

II — OPERATIONS

The extrusion of steel consists of the following sequence of operations:

A. Preparation of the billets — The billets are first cut to fixed lengths which are established in advance as required by the conditions of extrusion: type of steel, temperature of extrusion, extrusion ratio, etc. For this purpose, large diameter saws have been used.

Hot-sawing has not yet been experimented with by reason of the disadvantage that exists of not having the faces of the billet flat and perpendicular to the axis.

B. Preheating — The billets are heated to the highest temperature that it is possible to obtain with the furnace employed, without scaling.

Gas furnaces are preferred for this purpose.

It is necessary to state that it is difficult to attain extrusion temperatures of 1150 to 1250 C, without producing scale. A final heating with exclusion of air is thus generally necessary.

However, in the case of particular alloys resistant to oxidation, heating in a gas furnace can be carried up to the extrusion temperature. This is particularly true with alloys of the Inconel type, but encouraging results have been obtained in tests heating 18-8 stainless steel in a gas furnace.

C. Final heating — This operation is now performed in electrically heated baths of molten salts. This has certain advantages:

1. Heating in absence of air.
2. Dissolution of superficial oxides and conversion of these oxides into viscous products.
3. Rapid heating aiding this conversion.
4. Uniform heating.
5. Coating of the billet with a film of molten salt which protects it from oxidation during handling up to the moment of extrusion.

On the other hand, this heating method has certain disadvantages of an economic nature:

1. High heating cost, the furnaces consuming large quantities of electric power and having high maintenance cost.
2. Introduction of an additional step in the process.

There is thus great interest in reducing the time of holding in the salt or doing all the heating to extrusion temperature, without scaling, in one furnace.

Numerous tests now in progress will soon result in substantial improvement in these heating methods.

At this point in the presentation it appears desirable to show the sequence of press movements following the introduction of the heated billet into the container, in the production of a solid section. These successive movements are illustrated in Figure 1.

D. Piercing — When producing tubes by this process it is necessary to pierce the billets on a separate press, to a diameter slightly greater than that of the mandrel of the extrusion press. After this piercing operation the billet is reheated in the salt bath and then extruded.

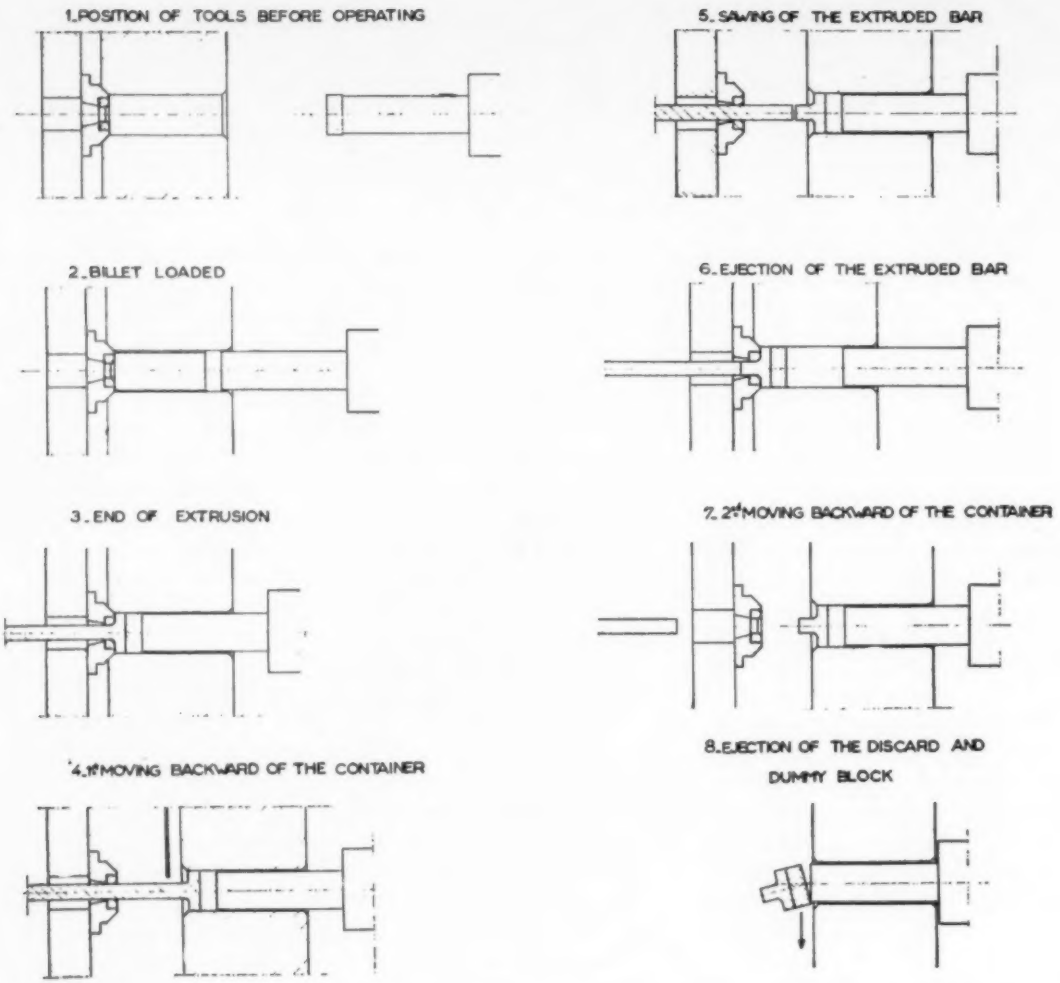

1. POSITION OF TOOLS BEFORE OPERATING
2. BILLET LOADED
3. END OF EXTRUSION
4. 1st MOVING BACKWARD OF THE CONTAINER
5. SAWING OF THE EXTRUDED BAR
6. EJECTION OF THE EXTRUDED BAR
7. 2nd MOVING BACKWARD OF THE CONTAINER
8. EJECTION OF THE DISCARD AND DUMMY BLOCK

Figure 1 — Sketches show sequence of extrusion operations.

Piercing is accomplished after preliminary compression in order to insure best concentricity of the hole. The piercing pressure will be high, since the billet has been compressed; therefore vitreous products are used as lubricants in this operation also.

The removal of the blank may be undertaken on the same press or on a separate press of very small size.

In some special instances, particularly if it be a matter of thick-walled tubes, there is the possibility of effecting the piercing operations on the extrusion press itself. This procedure has, however, the disadvantage of substantially reducing the production of the extrusion press so that for high production capacity it is definitely advantageous to separate these operations and perform them on different equipment.

The press movements following piercing are similar to those shown in Figure 1, except for the presence of the mandrel over which the sleeve or sock of glass is slipped to provide lubrication for the internal surface of the tube.

E. Untwisting and straightening — After extrusion, the bars are allowed to cool, in full length. They are then straightened and untwisted if required on machines operating under tension.

This method of procedure has the advantage of breaking away and discarding the particles of oxide formed during cooling, now mixed with the vitreous products remaining from the lubricant.

F. Cleaning — When perfect cleaning of the extruded products is desired, the removal of oxide and glass is completed by chemical means, either with hydrofluoric acid or by sodium hydrate.

III — PRODUCTION

A. Production rates and output — It is not without interest to recall that initially for several months the small experimental press of 600-metric tons made scarcely more than one cycle per hour. On the same press, in 1948, an average of six cycles per hour was secured.

When the 1500-metric ton press was installed at Persan, 9 pushes per hour were obtained. In 1950 the average rose to 12, in 1951 to 18, and in the first months of 1952 had gone up to 26 with occasional runs at 40 per hour.

The new presses installed in the United States should reach 60 strokes per hour. It is believed that this figure can be exceeded when all of the improvements to the equipment that have been described herein, are put into effect.

Quite understandably, the tonnage produced will depend on the weight of the billets entering the container. This weight in turn is dependent upon the nature of the steel to be extruded, the magnitude of the deformation required, and the power of the press used.

Thus it is possible to discuss production only when all of the factors are known. In order to clarify these thoughts, Figure 2 has been prepared showing the minimum and maximum monthly tonnages that it is

possible to extrude on presses of various load capacities in several typical steels, assuming three shifts and 500 working hours per month. Both ordinate and abscissa are in metric tons.

It may be seen from this chart that extrusion presses can produce tonnages of considerable magnitude.

B. Conversion cost — To the extent that the designs of extrusion presses are simplified and the operating rates increase, conversion cost decreases and approaches closer and closer that of rolling.

Extrusion is of great interest when dealing with the production of tubes and sections of special steels. The press does not compete with the rolling mill when considering rounds and simple shapes made in large quantities in ordinary carbon steels. On the other hand, for non-standard or special or difficult shapes and for tubes, there is need to examine in each case whether extrusion cannot bring greater advantages than rolling.

In closing, it seems worthwhile to add that many believe that the standard hot working facilities have now reached a degree of perfection such that the further improvements remaining to be made in this field will be slow, and there is little likelihood that they will be of revolutionary character. It is believed, on the other hand, that a process which in 10 years has taken its place in the field of metal-forming at high temperatures, has an excellent future since those who know the details well, understand that there are innumerable improvements that engineers and operators will not fail to bring to light.

DISCUSSION

PRESENTED BY

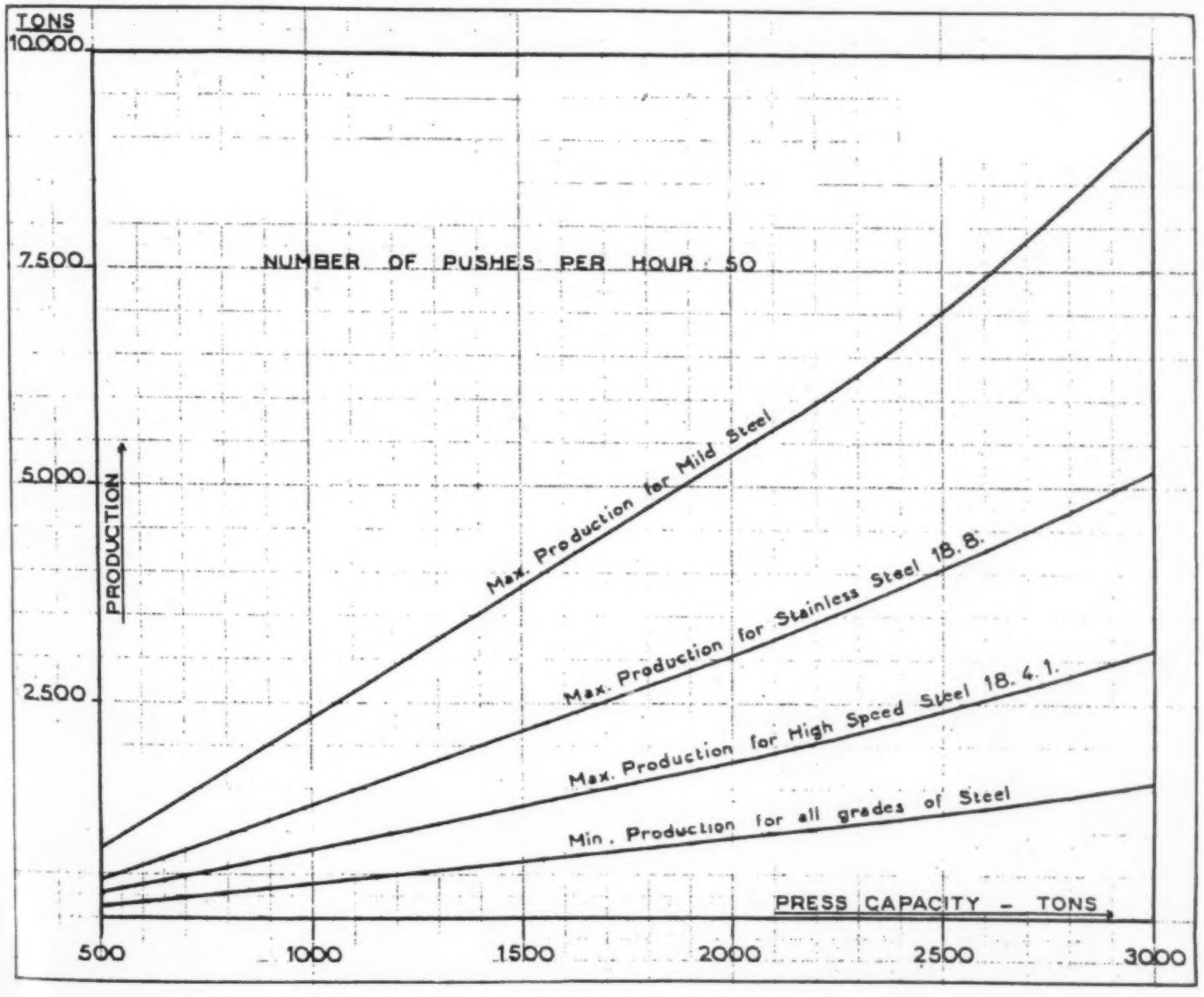
EMIL KERN, Vice President in Charge of Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

EUGENE M. SMITH, Mill Research, Development Department, Youngstown Sheet & Tube Co., Youngstown, Ohio.

JEROME STRAUSS, Vice President, Vanadium Corp. of America, New York, N. Y.

Emil Kern: The information offered in Jaques Sejournet's paper indicates that a sizable and useful amount of work has been done to assure successful

Figure 2 — Chart gives monthly production possible on various capacity extrusion presses, based on 500 working hours.



extrusion of steel. It appears to me that the most important thing contributed to the art of extrusion is a formula with substantiating technical data to permit everyone of us to solve their own equations. While employing an empirical approach to the problem of extrusion, he later evaluated his experience and expressed it in some academic form to enable us to get a better understanding of the present-day limits of the process under such and such conditions.

Now, I believe you all may like to have more practical data than was covered in Sejournet's paper, but remember, the process is still in its infancy. I am confident, however, that this next year and the years to come will bring about some remarkable changes in this whole operation, because I have great faith in our hard-hitting steel operators. They will make a go of it, and for my money and I am speaking as an engineer, I prefer five operators to five engineers in this matter of extrusion.

Eugene M. Smith: There are three questions I should like to present for further discussion:

1. It is stated that the extrusions press ordered in 1942 was obsolete before it was placed in operation in 1949. What is the basis for this statement? Was the press out of date in comparison with extrusion presses being installed in countries other than France, or was the press obsolete as a result of the long delivery time and improvements in design during the seven-year interval?
2. Is changing the container frequent or necessary for reasons other than to accommodate a change in billet size?
3. It is stated in the paper that in recent years there have been new developments in lubricants for use in extrusion. Does this statement infer that a departure from glass lubricants might be expected?

Jerome Strauss: The replies to the three questions posed by Mr. Smith are as follows:

1. Mr. Sejournet informs me that it was not entirely precise to state that in 1949 their press was already too old to undertake the work that they demanded of it because at that date they were just putting it into operation. However, during the course of the subsequent three years their rate of progress on both the process and the use of the press was such that the press aged at an overly rapid rate, which is one of the reasons why the press has undergone an almost complete modification during the summer of this year. It is, however, precise to state that the presses ordered in other countries and particularly in the United States, since 1949 were technically greatly advanced over the press at Persan.
2. In the Persan press no such change was required during these three years other than for a change in billet size.
3. There has been no departure from the glass lubricant. The new developments have all concerned the form and composition of the glass.

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FACTORS INFLUENCING SURFACE QUALITY OF HIGH SULPHUR STEELS

By GEORGE G. BLEAN
Steel Works Metallurgist
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

. . . . no single factor will give quality in the production of high sulphur steel . . . . careful steelmaking practices, correct handling and rolling procedures are all essential . . . .

▲ SULPHUR imparts two very important characteristics to steel. One is the greatly improved machinability imparted to the steel by its presence. The other is hot shortness which causes steel to crack and tear during hot rolling. To lessen this latter tendency careful handling and rolling procedures are necessary. Numerous operating and metallurgical factors affect the surface quality of these grades and no single feature can be pointed out as a panacea. This paper will deal with a few of the factors which appear most influential.

MOLD CONDITIONING

It is not intended to extol the virtues of any particular mold coating, but merely to show that good mold coatings do have a beneficial influence upon the surface quality of high sulphur steels. Mold coatings do not affect the hot short characteristics of these grades but do reduce minor imperfections due to splashing. Table I shows the effect of uncoated, pitch sprayed and tar dipped molds upon the surface quality of the high sulphur killed grades. The surface quality index referred to is based upon diversions and rejections; hence the higher the surface quality index, the poorer the surface quality of the billets.

TABLE I

Effect of Mold Preparation on Surface Quality

	Surface quality index
No preparation	10.1
Pitch spray	8.9
Tar dip	5.1

MOLD DESIGN

It is desirable to pour high sulphur steel into round molds rather than into square or rectangular molds. The inherent freezing characteristics of round ingots result in less cracking when blooming round ingots than when blooming square ingots, and results in a superior billet surface. Another reason which may be even more important for the superiority of the round ingot is the light drafts which the blooming mill must use in the initial shaping passes. Table II shows the effect of round and square ingots upon the surface quality of C-1117 and C-1118 grades. The molds indicated are all big-end-up type. The 29-in. round and 26½ × 28½ in. are corrugated and the 24 × 26-in. mold is flat sided. Although round ingots are desirable from a quality standpoint, the time consumed in shaping the round into a square imposes a penalty upon blooming mill production and for this reason it is generally advisable to use round molds only on very critical grades.

TABLE II

Effect of Mold Design on Surface Quality

	29-in. Round, surface quality index	26½ x 28½-in., surface quality index	24 x 26-in., surface quality index
Low C—high S	19.4	22.4	35.3
High C—high S	3.2	7.5	8.2
Low S grades	5.0	8.5	9.0

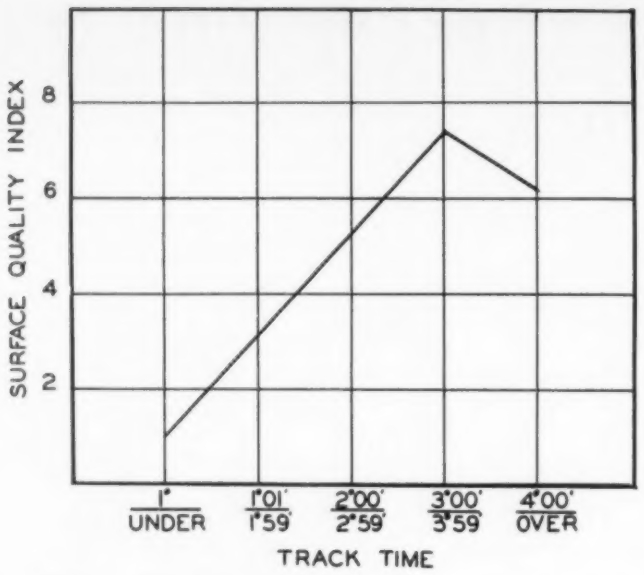


Figure 1 — Graph shows the effect of track time on surface quality on grade B-1113 steel.

TRACK TIME

Track time is the interval from the finish of pouring to the charging of the last ingot of a heat into the soaking pits. This factor has a very pronounced effect upon the surface quality of high sulphur steel and should be as short as the mold practice and grade of steel permits.

Figure 1 shows the effect of track time upon the surface quality of B-1113 which is a very sensitive bessemer

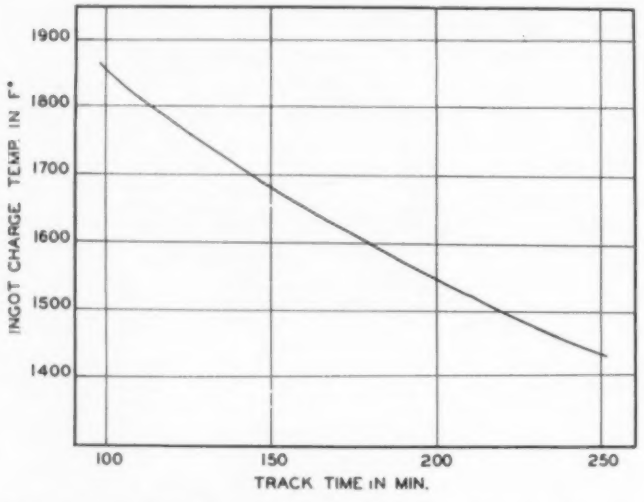


Figure 2 — Chart shows effect of charging temperature on track time for grade C-1117 steel.

grade with sulphur content between 0.240 and 0.330 per cent. This shows that track times should be maintained at one hour and under for best surface quality. The apparent inconsistency which appears at track times of four hours and over is due to the inclusion of data from ingots charged cold. The surface quality of billets from ingots charged cold is better than that from ingots which have had long track intervals, provided the cold ingots are charged into chilled pits and properly heated.

Track times are determined largely by the geographical layout of a plant, but it is generally possible to maintain one hour track times for the bessemer grades by delivering the ingots in one or two blow drags. For large heats of open hearth semi-killed grades, the first half of the heat can be moved at the completion of pouring and the second half 15 minutes later.

The killed grades such as C-1117, C-1118 and C-1119 must remain at the pouring platform approximately one hour, depending on the ingot size, to insure solidification. Track times of two hours are considered satisfactory for these steels. These grades are generally poured into big end up ingots and in most cases are removed from the molds by the soaking pit charging crane, and since the ingots remain in the molds up to this point do not dissipate as much heat as do the big-end-down ingots from which the mold is removed at the stripper yard. Figure 2 shows the effect of track time upon ingot charging temperatures for ingots poured into big-end-up molds.

HEATING

With high sulphur grades as with other grades, good uniform well soaked ingots are required for best rolling performance.

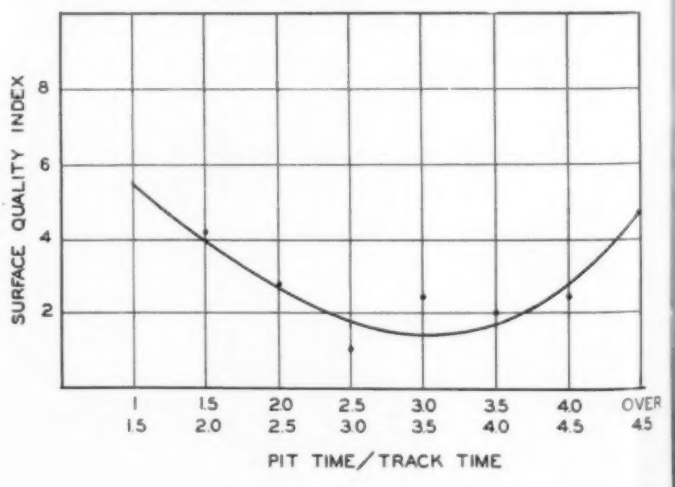
Figure 3 shows the effect of pit time/track time ratios upon surface quality. Best results are obtained with ratios of 2.5 to 3.5. These results are based upon normal track times and do not apply for ingots with excessive track times. The ingots involved in this study are 25 × 27-in. corrugated bottle top type with track times under 1½ hr. Pit time/track time ratios will vary from plant to plant depending upon ingot size, type of soaking pits and manner of firing the pits.

Figure 4 shows the effect of blooming mill finishing temperatures upon rolling quality. It will be noted that the surface quality deteriorates rapidly when temperatures are below 2000 F.

ROLLING

When blooming high sulphur ingots light drafts of about 1 to 1½ in. should be made on all sides in the

Figure 3 — Effect of pit time to track time ratio on the surface quality index on grade B-1113 steel.



initial few passes. From this point, it is best to bloom the ingot down as fast as possible so that the major work is performed on the ingot before any appreciable cooling occurs.

The number of passes and the amount of draft that should be taken when blooming high sulphur ingots is a much debated subject, however, extensive experiments indicate that heavy drafts are not harmful provided that the ingot is well heated and that the first few passes on each side are light.

Another factor which seriously penalizes surface quality is ingot delays between the soaking pits and the blooming mills. Delays here chill the surface of the ingot and result in cracking in the initial passes, although no appreciable drop in finishing temperature may be apparent. Some experiments wherein ingots of B-1113 were delayed from 2 to 5 minutes before rolling results in a surface quality index of 12.8 as compared to 4.1 for ingots rolled with no delay. This is an appreciable difference and shows how easily a good heating job at the pits may be spoiled by poor handling between the soaking pits and blooming mill.

Even with the best steelmaking and blooming mill practices, high sulphur steels will crack to some extent during rolling. To reduce the incidence of cracking special practice and equipment are used.

The term saddening refers to the practice of taking a few light passes on an ingot then returning it to the soaking pits for re-heating. After the saddened ingot has been properly re-heated, it is then bloomed down in the normal manner. This practice toughens the skin by breaking up the initial cast structure and results in less cracking during the blooming operation. Saddening

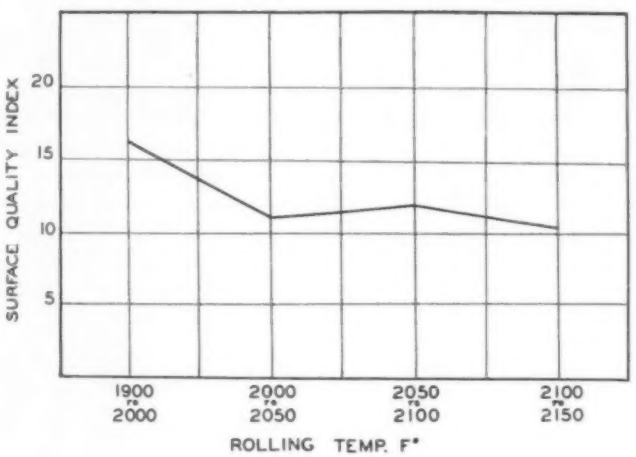


Figure 4 — Effect of rolling temperature on surface quality for grade B-1113 steel.

however, imposes a heavy penalty in soaking pit capacity and production rate, and can only be performed to a limited extent in most blooming mills.

Figure 5 shows the effect of saddening upon the surface quality of billets of C-1115 and C-1120 grades. Each of these points is based upon the per cent of steel saddened during three month periods. The tonnage involved during each period is about 3000 tons. This indicates that saddening greatly benefits the surface quality of high sulphur steels.

Table III shows the effect of hot scarfing or desurfacing upon the surface quality of high sulphur steels. The hot scarfer in this case is located between a two-high 44-in. blooming mill and a three-high 28-in. mill. The blooming mill delivers an $8\frac{1}{2} \times 7$-in. bloom and the entire surface is removed from each side to a depth of $\frac{1}{16}$ in. The blooms are then reduced to 4 - 5 and 6-in. billets. The hot scarfer is not selective and must remove the entire surface of the blooms. The depth of removal can be controlled by the amount of gas pressure and the speed of the bloom through the unit.

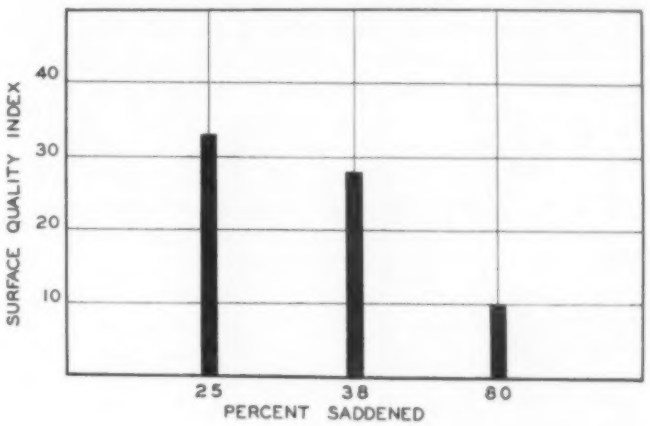


Figure 5 — Effect of saddening on surface quality on grades C-1115 - C-1120 steels. Saddening markedly improves surface quality.

The hot scarfer does not eliminate billet reconditioning, since defects such as deep seams and cracks are minimized but not removed. The scarfing rate shown in Table III illustrates the improvement in billet reconditioning effected by the hot scarfer.

Throughout this paper the rolling and handling of high sulphur ingots have been discussed. This is because the major difficulties are encountered in these stages of processing. When re-rolling the billets into bar product, hot shortness is not encountered as it appears to be most troublesome in the cast ingot structure. No cracking or tearing occurs in the finishing mills, although some difficulty is encountered due to split ends when rolling the very high sulphur grades.

TABLE III

Effect of Hot Scarfing on Surface Quality

	Surface quality index	Tons per man-day, scarfing rate
Hot scarfed	11.0	23.0
Not hot scarfed	20.0	12.5

SUMMARY

In conclusion, there is no single factor which is a panacea in the production of high sulphur steel. Careful steel making practices are necessary as well as correct handling and rolling procedures. When there are errors somewhere during processing, the quality must and does suffer.

DISCUSSION

PRESENTED BY

A. T. HUBBARD, Open Hearth Metallurgist, Youngstown Sheet & Tube Co., Youngstown, Ohio.

D. C. HORSMAN, Superintendent Steel Division, Continental Steel Corp., South Kokomo, Ind.

GEORGE G. BLEAN, Steel Works Metallurgist, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

HARRY W. CLARK, Open Hearth Metallurgist, Ford Motor Co., Rouge Plant, Dearborn, Mich.

W. W. HOFMANN, Assistant Superintendent, Johnstown Plant, Bethlehem Steel Co., Johnstown, Pa.

H. N. MEYER, Metallurgist, Bethlehem Steel Co., Johnstown, Pa.

V. W. JOHNSON, Superintendent Rolling and Finishing Departments, Colorado Fuel & Iron Corp., Minnequa Works, Pueblo, Colo.

A. T. Hubbard: The main factors of Mr. Blean's paper express exactly what we strive for in our resulphurized steel. We cannot add anything to the factors of mold coating or mold design. All our molds are sprayed with "esso" and all the heats are poured into 23 × 25-in. big-end-down or 25 × 25-in. big-end-up molds.

Concerning track time, our bessemer screw stock is handled rapidly by delivering only two or three blows (6 or 9 ingots) and the track time will average close to one hour. Open hearth heats are much harder to handle; we have tried delivering half heats of semi-killed steel, but encountered quite a few mold stickers which caused us to lose too much time. At present we pull the heat intact as soon as finish pour and deliver intact if no delay is encountered, if for any reason the heat is delayed in transit we strip and deliver half at a time. Using this method we are able to maintain a delivery time of approximately the same as our bessemer.

We have found the heating practice to be very critical; we aim for at least 2.5 - 1 pit time to track time ratio, 2400 F minimum draw temperature, and finish roll temperature of 2130 - 2150 F. To control our setting time on bessemer steel, which is our largest quantity produced, a man from the metallurgical department using an optical pyrometer works in cooperation with the heaters. This practice has enabled us to practically eliminate bellied ingots and give us more uniformly heated ingots.

D. C. Horsman: I understand that Jones and Laughlin have made many experiments regarding the effect on surface quality of using the diamond and square reduction method in the production of billets, and in roughing passes on small sections.

According to some of the results that I have heard, this has a very marked effect on surface quality and I would like to ask for Mr. Blean's comments on this phase.

George G. Blean: I have no concrete figures to offer on the effect of the diamond and square passing, but it has definitely improved the surface quality of our bar steel.

Harry W. Clark: Surface quality of sulphur steel has long been a problem to the operators. Due to the variables involved, meticulous attention is required if prohibitive conditioning costs and abnormal billet rejections are to be avoided. In view of the many sources of defect origin, no one department should be overlooked, as each has a contribution to the final outcome of the product.

The low carbon, low manganese grades, such as 1109, 1117, and 1120 are among the most difficult to produce with consistently low surface rejections. We are in accord with Mr. Blean's statements, and feel that not enough emphasis can be placed upon departmental responsibilities.

We have found that highly contaminated scrap has a very detrimental effect on sulphur steel. The use of excessive amounts of sulphur back crops in any one heat is discouraged, as a low sulphur preliminary is desired. Our practice reveals that a more consistent surface quality is obtained where the residual sulphur is 0.030 or less.

In regard to final analysis, it is sufficient to say that the higher the manganese and the lower the sulphur, the better, as long as both are within the desired chemical specification.

We are firm believers in mold coatings for the production of bar steel, regardless of type. At present, we are coating molds with graphite to obtain a better surface quality. We are developing another mold coating to do a universal job of decreasing mold cost along with improved surface quality.

Regarding mold design we have poured into a 22½-in. round mold with favorable surface conditions. Due to bar steel limitations, we are now teeming into one size bar mold a 24 × 26 in. five-ton, big-end-up. Surface conditions of the round mold are an asset.

Track time is a most important factor to be considered in producing good surface quality. I would like to substantiate the previous speaker's statements and add that we have found surface conditions affected as much as double where track time was permitted to exceed four hours. Our ultimate aim is to have the entire heat completely under cover in the soaking pits in three hours or less. We also consider track time from finish pour to finish charge in soaking pits. The heats are held at the pouring platform for twenty minutes after finish pour and then moved to the mold building where the hot tops are removed. In the event of delayed charging, we loosen the ingots from the molds. Ingots that have been allowed to become cold can produce as good a surface quality as hot ingots, providing they are placed in chilled pits and allowed to equalize before the cover is closed and firing commences. This procedure, however, is detrimental to production, and should be avoided wherever possible.

Heating ratio varies with the types of pits charged. Best practice was found when a pit time to track time ratio of two to one was maintained. We advocate slow heating, gradually increasing the rate of temperature rise as higher temperatures are attained, with strict adherence to heating cycles.

Our soaking temperatures are much higher, due to the lower carbon, lower sulphur specifications produced. These low carbon grades are drawn from the soaking pits at 2400 F. This maximum temperature seems to

be best suited to render the metal plastic enough to flow uniformly when subjected to the blooming operation.

Light initial passes, with equal work on all sides, while breaking down the ingot, along with minimized water on the rolls is of great importance. Fast working to finish rolling is essential.

We do not employ the saddening method. However, we have used it from time to time in the past. It is helpful in producing a better surface, but a definite handicap to production.

Our hot scarfer is located between the 44-in. blooming mill and the bloom shears. Approximately 3/64 in. is removed from each of the four sides of the bloom.

In conclusion, I reiterate that no one single factor will guarantee desired surface quality. Since this is a most difficult grade of steel to produce successfully, it is absolutely essential that the utmost care be exercised in each phase of production.

This care can only be obtained through a thorough knowledge of the best production processes and the personal pride and effort of the men involved.

W. W. Hofmann: Several years ago, in the spring of 1945, a group of rolling mill experts were gathered at the 48 and 18-in mills in Johnstown, Pa., to watch the results of following very carefully, a practice which embodied the best that has been set forth to us today. Bessemer screw-stock 1113 grade was involved and we were rolling direct from the 22 × 25-in. ingot to a 2½-in. billet without "saddening" or "double heating," having newly installed a hot scarfing machine which was to eliminate this double heating.

We had fulfilled practically all the provisions Mr. Blean has specified, with the exception that our ingot was not round — it was rectangular. What was the result? The first heat came through the mill and the top one-third was extremely rough — "alligator hide," we termed it. The next heat came through and it was nearly perfect — well over 70 per cent of the billet product satisfactory without necessity for further reconditioning. The third heat came through and the bottom portion — perhaps the entire bottom half, was very badly cracked with considerable scrap.

The same soaking pits and heating practices were involved in good and bad heats and this only furthered a conclusion which we had reached long ago, that it is vitally important to have the steelmaker's cooperation in attaining the quality we wanted. I believe that my rolling mill friends share the same feeling in this matter.

Mr. Blean, yours is a very excellent paper, embodying the best we know in handling high-sulphur steels. Perhaps the only recommendation I could make is that we enlist your very capable assistance in developing the reasons why some heats roll good and others poorly, under what are apparently identical conditions. Some overlooked improvement factor which I strongly suspect is in the making of high-sulphur steels, is yet to be found.

H. N. Meyer: My remarks will be confined to bessemer and bessemer equivalent grades. As brought out by Mr. Blean, minimum track time is essential, together with proper heating intervals. Pit time must be sufficient to avoid ingot cracks, but not so long as to result in scaling into the blowholes. We have found fast movement, leaving gas off about one-half hour after charging, and heating with low Btu gas to yield best surface quality.

"Saddening" is undoubtedly beneficial to surface quality. However, with proper handling and hot scarfing, good surface can be obtained on direct rolled material. The latter method is advantageous from a production and cost standpoint.

Our experience bears out Mr. Blean's statement that diamond-square pass design improves surface quality. Our 18-in. continuous billet mill has been relocated and modernized with diamond-square passes throughout. Considerably improved surface has resulted. It should be emphasized, however, that neither pass design nor hot scarfing will eliminate the major defects resulting from mishandling in earlier heating and rolling operations.

V. W. Johnson: I wonder if some of us are missing the boat metallurgically. We have surface condition problems, although we do not roll large amounts of high sulphur steel. My question might have some bearing on better surface control. We at Colorado Fuel and Iron are now and have been experimenting with various types of scale that we can produce in our soaking pits. I am wondering if Mr. Blean has done any research work on Types of scale possible in the various grades of ingots.

George G. Blean: No, I have not. We get a very heavy flaky scale, using coke oven gas.

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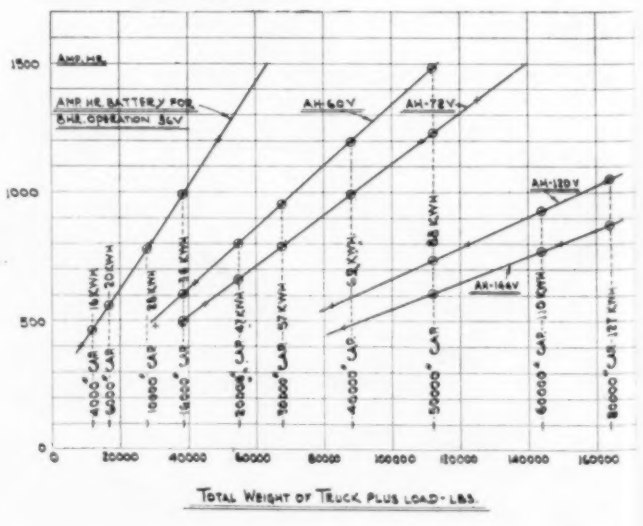
▲ IN the early days of industrial trucks, the duty cycle was very light and the loads that were carried were what we would today call light. Common battery in those days consisted of a 24-volt battery having about 250 amp-hr or 6 kwhr capacity. They could carry a load of two tons and were usually of the platform, either non-elevating or elevating type. This early equipment introduced industrial trucks to industry, and it was soon found that they could be used for many purposes beyond that for which they were originally purchased. As this condition developed to a greater extent, the demand on the battery increased, and it was not long before larger cells were required. Eventually it was found that these trucks required as large a low type cell as was built, and there was still not enough battery capacity to run a full day. The battery manufacturers realized this condition and developed the higher cell. This higher cell gave about 50 per cent more capacity and served as a stop-gap for quite a period of time.

It soon developed, however, that the activity of the trucks became still greater. In addition to this, the weight of the trucks increased, particularly with the introduction of the fork lift type of machine. When this condition developed it was found necessary to go to the maximum size of higher cell battery on a 24-volt machine.

The next stage of development was to increase the voltage from 24 to 30 volts, and it was not long before even this increase in kwhr due to the higher voltage was insufficient. It will be found in today's practice that the majority of the larger trucks, say from 4000 to 8000-lb capacity, the industry had pretty generally standardized on 36 volts. With this higher voltage and the large cells that are available today, they have sufficient capacity to run a full turn.

The next development was the introduction of high capacity machines, particularly of the fork and ram truck type. On the early machines of this type, the voltage was increased to 48. It was soon found that this was not sufficient even when using a maximum size of high type cell. The obvious move was to increase the voltage beyond 48, and the figure of 60 or 72 volts was chosen. Now 72 volts had an appeal to many customers due to the fact that it was exactly double the voltage of their smaller trucks, and could be charged in sections with the same charging equipment. This condition, however, did not remain static for long, as it was found that when carrying product, such as in a steel mill, the activity of the truck was continuous and the largest high type cell, even in 72 volts, was not sufficient to carry on for a full day. When this condition became obvious, the battery companies again developed a new cell to give still greater activity. This cell is what we now know as the MEH Exide or the D Type Edison, which gave us a capacity of approximately 33 to 100 per cent greater than the previous high cell. These much higher type cells have done an excellent job in the steel industry, where trucks are big and the duty cycle severe. They not only provide sufficient capacity for a 6 to 8-hr turn, but in addition to that, give long life due to the fact that the battery is large enough in capacity to avoid overheating when in continuous operation. Nearly all these jobs are running around the clock with only two sets of batteries per truck. This means that as soon as the battery comes out of the truck, it must be immediately charged. After it has

Figure 1 — Chart shows battery capacity required for six to eight hours operation.



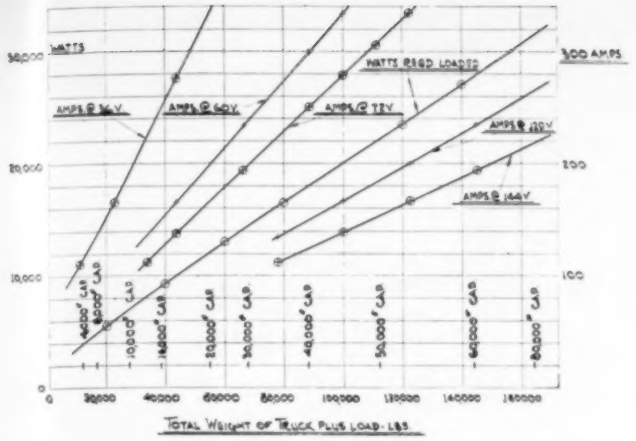


Figure 2 — Chart shows approximate amperage required for a loaded truck on level concrete.

been charged it must immediately go back in the truck into full duty operation. The battery manufacturers and the truck manufacturers have always recommended three batteries in such an operation, but I know of a number of jobs where this recommendation has not been followed and the customer is still getting quite satisfactory results.

On these large machines the most commonly used voltages are 60 and 72; the higher voltage being the preferred voltage, and the largest cell available is 1500 amp-hr. The next smaller size of cell is 1000 amp-hr. With the cell of this capacity our experience indicates that it will supply sufficient power for a 40,000-lb capacity truck over a full turn. If you want to increase the capacity of the truck to 60,000 lb, it is my opinion that the 1500 amp-hr capacity battery is required. As a matter of fact, if anything, it is on the light side. Figure 1 illustrates our experience relating to kwhr required of the battery for trucks of various capacities. We have also shown the total weight of the truck plus load, as it is this which the battery must really power, and the figures represented — in my opinion — are fairly accurate for all makes of machines of this type.

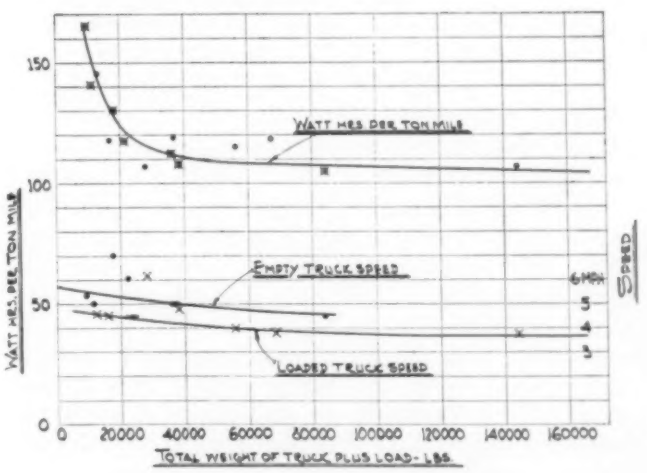
In addition to battery capacity, there is a second requirement for connecting the battery to the motor. This means wiring and control equipment. We all fully recognize the problems that develop in the attempt to run large motors at low voltage. The amperage goes up, which means the wire size and apparatus goes up with it. Figure 2 shows the approximate amperes required to drive a loaded truck on level concrete at various voltages. These figures are averages as taken from actual readings of various trucks, and represent a value of watt-hours per ton mile, as shown on Figure 3. You will note that there is some departure between the readings and the curve, but for all practical purposes we can assume that the curve sheet is approximately correct. It must be also pointed out that the actual battery consumption of such a machine is influenced greatly by accelerating current requirements, and also by the requirement of using the battery to plug the motors, thus serving as a means of braking. We will grant that this should not be done, but actually it is practically unavoidable if the driver is required to get out real tonnage per day.

In all of these curve sheets, it is very important to point out that we have assumed a truck speed consistent with the job the truck is to do. The speeds that we recommend are shown on Figure 3, and you will note that speeds are somewhat slower on the heavy capacity trucks than on the lighter 4000 and 6000-lb machines. The reason for this lessened speed is entirely a matter of safety of operation, however, we do not recommend any substantial difference in speed between the 30,000-lb ram truck as compared to a 60,000 or 80,000-lb truck. The conditions of hazard on two machines of this type are the same as far as speed is concerned, and it would be inconsistent to slow down these extremely heavy machines merely for the purpose of reducing battery or motor requirements.

From the curve sheets you will note that the watt-hour requirements per ton-mile reduces sharply as the capacity of the machine is increased. This is probably a result of large tires and larger motors, which on account of their size can be built with higher efficiency. However, we have found that after we reach a capacity of about 30,000 lb, the efficiency of trucks with still greater load carrying capacity remains approximately the same, and on account of this will consume battery current in more or less the same proportion as the weight of the vehicle is increased.

From the above data we found that the current draw of a 40,000-lb ram truck with 60-volt battery will run around 300 amp, whereas with the 72-volt battery would only be 225 amp. If, however, we change to a 144-volt motor we would only require 112 amp. With a machine of 40,000-lb capacity we are pretty near the limit of a 72-volt battery from the standpoint of overall efficiency. As we go larger than this, however, say to a 60,000-lb machine, the current draw would run around 380 amp at 72 volts. If, however, the battery voltage is increased to 144, the amperage comes down to approximately 190 with the full load, and this is an acceptable figure whereas the other is really on the high side. It might also be pointed out that the most common form for these high capacity machines is to employ two drive motors in series with each other. When this is done, the voltage rating of each of the individual motors is half the battery voltage. In other words, when a 72-volt battery is employed, each of the motors must be designed for 36-volt rating, and when connected in

Figure 3 — Chart shows truck power consumption and speed for various weight trucks.



series gives total voltage requirements of 72. I believe that when dealing with motors of approximately 15 hp each, we cannot expect ideal operation if we limit our voltage to 36.

The final consideration in connection with truck voltage is that of safety from electrical shock. There is no question but what the safety is increased as the voltage is dropped, but it would be my opinion, that 144 volts is well below the real danger point. The wiring should be conduited and well protected to avoid the possibility of contact with the wiring system. I believe that this requirement also exists on the lower voltage machines, not from the standpoint of shock, but from the standpoint of good practice and durable wiring. If we attempt to go much higher than these 144 volts, however, the electrical shock phase becomes still more important and may be objected to by some operators. Higher voltage than this also imposes the problem of the battery itself. More cells gives a poorer space factor for the battery than would be the case with 144 volts. This is due to the fact that each cell in effect loses one plate, and requires a double thickness of jar to contain its electrolite. As cells become smaller, the space efficiency per kwhr is somewhat reduced, and inasmuch as space is at a premium even on these large machines, this condition can become a factor.

In conclusion, the important point I wish to make is, first — the speed of the large machine should not be sacrificed to conserve power, and second, the duty cycle or trips per day should be substantially the same for a big truck as it is for a smaller one, and the tonnage increased by the increase in capacity. We give full importance to these two factors. Good engineering practice dictates the higher voltage batteries on trucks heavier than the 40,000-lb ram truck bracket.

DISCUSSION

PRESENTED BY

J. W. McNUTT, Tractor Shop Foreman, United States Steel Co., Irvin Works, Dravosburg, Pa.

CHARLES S. SCHROEDER, Director of Engineering, The Yale and Towne Manufacturing Co., Philadelphia Division, Philadelphia, Pa.

HARVEY DEMMON, Superintendent Maintenance, United States Steel Co., Irvin Works, Dravosburg, Pa.

M. R. McCONNELL, General Industrial Consultant, West Penn Power Co., Pittsburgh, Pa.

R. T. LUCAS, Electrical Superintendent, Weirton Plant, Weirton Steel Co., Weirton, W. Va.

J. W. McNutt: Do you think 144 volts is enough on the 80,000-lb truck?

Charles S. Schroeder: About 144 is a compromise between what you would like to have, and being safe from the human angle, as far as electrical shock that might result if something is not properly maintained or something is defective.

We have built trucks, diesel equipment, where we used 350 volts. We did that because that was standard switch locomotive voltage, with standard generator. However, a great many steel mill operators object to so high a voltage.

If some wire were loose, I do not know how, but it can always happen, the shock resulting from 350 volts would be severe. The shock resulting from 144 might not be pleasant, but it would not be fatal in ordinary cases. So our limit of 144 is placed more because of the danger element than that it is what we would like to have.

J. W. McNutt: What is the current at 144 and 350 volts?

Charles S. Schroeder: With 144 volts, full load on 80,000-lb truck, is 210 to 220 amperes. That is not too bad. It is high but it is not too bad. On 350 volts, it would be on the order of about 100 amperes. I am talking about operation on level concrete roadway.

J. W. McNutt: Comparing a truck with batteries and a truck with a motor-generator set, what difference, if any, is there on the counterweight?

Charles S. Schroeder: Where you have a battery that weighs 10,000 lb, it saves you an awful lot of lead counterweight.

J. W. McNutt: Would this battery extending to the center of the truck make any difference in the proportion of counterweight?

Charles S. Schroeder: No, it is at the rear end of the truck and is very effective as counterweight. As a matter of fact, the total weight of a battery truck, a lead battery truck with its counterweight, is very nearly the same as the total weight of a diesel-electric truck where the counterweight is substantially at the rear end.

Harvey Demmon: A considerable portion of this discussion has been about the electrical equipment on industrial trucks. The present problems have been brought about by the demand for trucks carrying heavier loads. Steel industry is going to adopt heavier coils regardless of whether they can be handled on industrial trucks or whether some other means of handling the heavy loads at a higher rate of speed will be found.

It appears to me, that both the truck manufacturers and the electrical equipment manufacturers have a problem, and that is, to meet the demand of the heavier loads. We believe, that the truck manufacturers should consider the mechanical portion of industrial trucks. The mechanical portion of industrial trucks has given as much, if not more, trouble than the electrical portion.

Charles S. Schroeder: I think what you say is very true. The steel industry has been ahead of the truck industry, because they design the process before we start to design the truck. Years ago when the steel companies were talking about 60,000-lb loads we thought they were fooling. When was the first continuous strip mill built? It is only about 20 years ago, or not much more than that. They went to what was then big coils, I think 7000 lb. We thought they were large.

Next they were going to weld two of them together and make it 14,000 lb, and we all said that is about the end of it, they are not going any higher than that.

Eventually they got up to 20,000. Then before they had settled into 20,000, it went to 30,000, 40,000, and then 60,000. We are even operating at 80,000 up at Lackawanna, carrying two coils of 40,000 lb each.

You see, we are new at this. You develop the mills and after you have developed the mills you come to us, and we have not had time to develop the trucks.

Trucks are going to be better. As a matter of fact, they are better today than they were only a few years ago.

Harvey Demmon: We still say that the steel industry is going to adopt bigger coils and some method of handling them will be found. Whether these coils are 50,000, 70,000 or 80,000 they will be handled in the most economical way.

Charles S. Schroeder: Well, you will not carry over 60,000 lb on the majority of steel mill floors. I have seen a lot of mills where they have only 6 and 8-in. concrete floors. That poses one problem. The later mills, where you have 10 and 12-in. concrete floors, you do not have the problems of floor breakage. When you go to 60,000 and 80,000-lb trucks, you have to consider your floors.

Harvey Demmon: We believe that the industrial truck manufacturers have a challenge to meet because larger coils are handled by other methods such as overhead traveling cranes and conveyors. If industrial trucks are to meet the competition of cranes and conveyors in handling large coils, they should consider the mechanical portion of the trucks as well as the electrical power portion.

Charles S. Schroeder: On two machines we put in at Bethlehem, we had electrical trouble but no mechanical trouble. We had a very interesting condition, where they move the steel from the skin pass mill to the storage area, a run of about 700 feet, and haul coils continuously. This long haul operation leaves the motor perfectly cool.

The next job is to take the coils out of that storage area, and put them on a scale, back the truck off, run back on the scale, and finally take them to the cars, a haul probably never over 40 or 50 feet. The motor gets very hot, because you are continually reversing. Our solution to this heating effect was to install a continuously running electric blower to keep the motors cool. Since this addition, no further trouble has been reported. We have not had mechanical trouble up to the present moment.

M. R. McConnell: You mentioned using 350 volts on the diesel-electric truck, but only 144 volts on the battery truck. Why not go to the 240 volts that you would like to use on your motors with your battery job, what is the objection to 240 volts on a large battery truck.

Charles S. Schroeder: There is no objection, we would like it. It does make a little more expensive battery, it poses some problems in charging that would make it complicated for existing equipment. The battery would cost a little more per kilowatt-hour, not much, but a little. Also, it takes too much space. When you go to more cells, every cell loses two thicknesses of jar and one plate. When you go to too small a jar, you lose efficiency. We would like to go to 240 volts. Storage battery locomotive voltages are such that they charge from a 230-volt line, that would be about 180 volts for the storage battery.

We prefer high voltage but we must compromise for all the conditions involved. We do not want 72 volts. On a smaller truck it is perfectly all right. The ideal voltage to me is to have the voltage about equal to the full load amperage, somewhere within that range, and then you get nice operation, 100 volts, 100 amperes. You could go to 250 amp and 250 volts. But when you go beyond that, 1000 amp and sixty volts is not good. When you go up to really high voltage you get commutation trouble.

I do not think any steel mill voltage goes over 550 volts on d-c, because of commutation trouble.

I would like 240 volts, but we cannot sell it.

R. T. Lucas: Is this voltage selection made entirely for battery-operated trucks? Where you are above 30,000 lb, you would go to 120 volts! Is that peculiar to battery-operated trucks?

Charles S. Schroeder: No, I would say that on gas or diesel-powered motor-generator trucks, that 144 is a type of generator you can get, diesel operated, and that is all right, it is not too low. While I would prefer it a little higher, apparently it is not standard at the moment.

R. T. Lucas: We have trucks of 15,000-lb capacity that are operating on 120 volts, and what I wanted to try to find out is where this capacity range changes in voltage.

Charles S. Schroeder: Although 120 volts on 15,000-lb truck is better than 72, you can get by comfortably with 72, or even 60 volts, on a truck up to 30,000-lb capacity.

R. T. Lucas: With reference to the theory on the contactors necessary to carry this heavier amperage with reduced voltage, would not the same thing apply to a 15,000-lb capacity truck with higher voltage?

Charles S. Schroeder: Definitely, yes. Because you do not start to have trouble with contactors on voltages until you get to around 200 or 300 volts. I think most commercial contactors are rated at 600 volts, so if you are below this you are perfectly comfortable as far as contactors go. But when you change from 60 amp to 300 amp, you require much larger control apparatus.

R. T. Lucas: That is what I wanted to know. We have several trucks of 15,000-lb capacity with 120 volts. Then it makes no difference what the voltage is if you can accommodate the voltage on the truck, whether it is 15,000 lb, 10,000, or 80,000 lb?

Charles S. Schroeder: Yes, it does make a difference, a practical difference. It makes a difference on the equipment we put in stock, the motors and the controls, and all the apparatus on the truck, particularly the motors, which are 12 to 14 months delivery. The ones we buy are the ones the steel industry selects as a whole as the most popular. It might not be what we would prefer, but it is what they select because of battery standardization in their own plant.

If we change that voltage, either higher or lower, we have to order a special motor and the answer is, "14 months if you can get it." So merely jumping around to different voltages, which may be more efficient, which may be better, is not necessarily a better solution because you cannot get the thing in short enough time.

R. T. Lucas: We started out with 120-volt units on these trucks, and 120-volt motors. Then during the war we were forced to go back to 60 volts.

Charles S. Schroeder: Your original idea of 120 volts was sound. It is a good voltage for that size machine, and it is not harmful if you do happen to touch a hot wire. But until the whole industry goes along with that, you cannot afford to stock motors for one of a fairly large group. I would rather have 240 volts myself, but 144 works well.

S. K. LESSEY, Manager Service Division, The Electric Storage Battery Co., Philadelphia, Pa.

Battery Charging Equipment

. . . . from a battery charging standpoint, the operator should have little concern as to whether power conversion is by electronic means or through rotating equipment . . . .

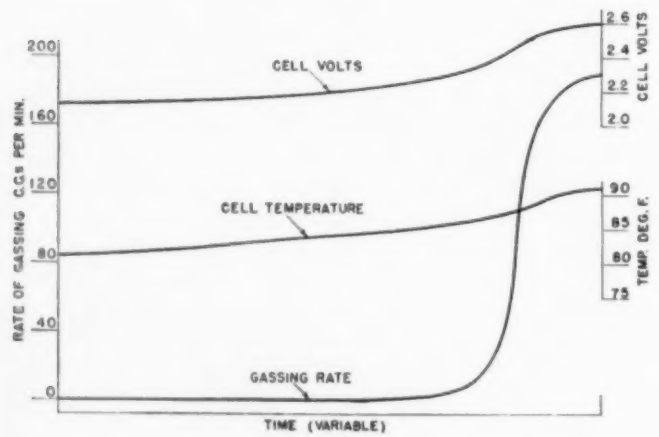
▲ MOST of us who have anything to do with storage battery charging today, take for granted the two usual methods of charging the lead storage batteries which power industrial trucks and tractors. These are the two charging methods commonly described by the names "modified constant potential" and "two-rate." They are fundamental to the design of the charging equipment, and a reasonable knowledge of their origin is desirable and will prove helpful in any study of charging equipment features and characteristics. Before discussing the various types of equipment, therefore, a short review of the charging methods that led to their development is in order.

In the early days of storage battery use in industry, little thought was given to charging methods. The commonest scheme was to select some charging rate which appeared suitable for the battery size and hold it approximately constant by manual means until the specific gravity of the electrolyte had been restored to its full charge value. Such a charge is shown in Figure 1. With this method there is a continuous rise in the temperature of the cells which becomes more pronounced toward the end of the charge when "gassing" begins. The "gassing" represents current which is wasted as far as charging the active material is concerned. It generates heat, creates turbulence, and causes excessive chemical and physical wear on the cell elements.

Constant current charging was not only inefficient from the start, but limited in application, because too much time was consumed in restoring a battery to a fully charged condition. This method, however, demonstrated that the basic considerations in shortening the time are temperature and gassing. Whatever the method of charging, the time cannot be reduced beyond the point where the charging characteristic will exceed the allowable temperature and gassing limits of the battery.

One of the first to study means of shortening charging time was Dr. J. L. Woodbridge, then chief engineer of my company, who was responsible for the development of the "ampere-hour law" of battery charging. This law states that "if the charging rate in amperes does not exceed a value equal at any time to the number of ampere hours then out of the battery, the conditions relative to gassing and temperature will be met." The law is shown graphically in Figure 2, from which it will be noted that 90 per cent of the capacity taken out may be put back in two hours and twenty minutes.

Figure 1 — Curve shows rate of gassing versus time for typical constant current charge.



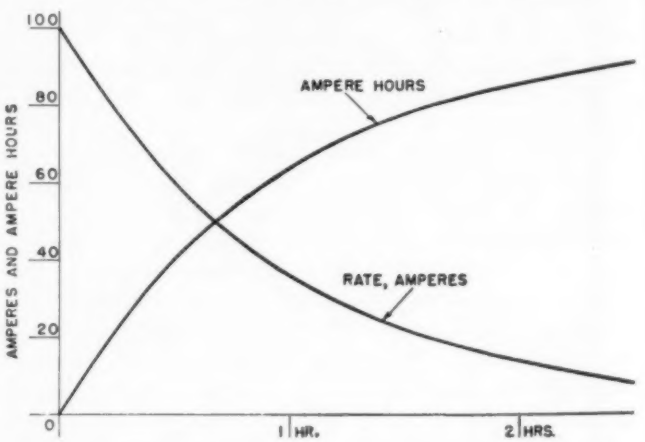


Figure 2 — When charging by ampere-hour law, it can be seen that 90 per cent of the capacity may be put back into the battery in 2 hours and 20 minutes.

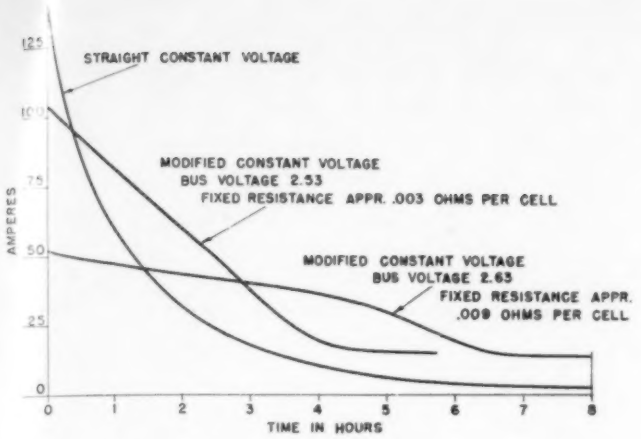


Figure 3 — Curve shows constant voltage and modified constant voltage charging.

Dr. Woodbridge's studies also developed the fact that by maintaining the voltage at the battery terminals constant, the charging characteristic closely follows the "ampere-hour law." This is shown by the curve, so identified, in Figure 3. While this method might have solved the time problem and was excellent from the standpoint of temperature and turbulence, it required, first, a practically constant voltage and second, a very high charging capacity to supply the initial charging rates. The charging equipment art had not then progressed to a commercial solution of the straight constant voltage design problem.

To overcome the difficulties of meeting the high initial charge rates, a small amount of resistance was introduced between the constant voltage source and the battery. Two variations of the resultant characteristic are shown in Figure 3. The lower one is the normally recommended charging characteristic for modified constant potential charging.

It was not too difficult to design a motor-generator set which would reproduce the recommended modified constant potential charging characteristic. Figure 4 is a typical charge by motor-generator. At this stage, however, most commercial rectifiers were essentially constant current devices and, in addition, there were many existing generators and other direct-current power sources with voltages far in excess of the limits practical for modified constant potential charging. There were "fringe" cases also where the power source voltages were variable and no recommended charging characteristic could be dependably produced.

The solution for these cases was based on recognition that most of the gassing and excessive temperatures occur in the latter part of the charge. Tests were made with actual batteries, using various bus voltages, and from the results, suitable paired values of resistance were adopted such that, when introduced in parallel between the battery and the charging bus, the battery would charge safely at a fairly high rate, later adjusted downward to approximately its finishing rate by open circuiting one of the resistors. Figure 5 illustrates a "two-rate" charge from a constant voltage bus.

The characteristics of "two-rate" charging from direct current buses were fairly easy to reproduce with rectifiers, and most metallic rectifiers today have output characteristics that closely resemble them. Figure 6 has been drawn from a field check of a metallic rectifier, made this year by one of our engineers.

With both methods of charging there remained the questions of when and how to terminate the charge and, in the case of two-rate charging, the additional problem of reducing the high rate to the low at the proper time. One of the early means, which is still in use today, was an ampere-hour meter equipped with contact points arranged to handle both the termination of the charge and any intermediate circuit changes. These meters

Figure 4 — Curve shows a typical charge with a motor-generator.

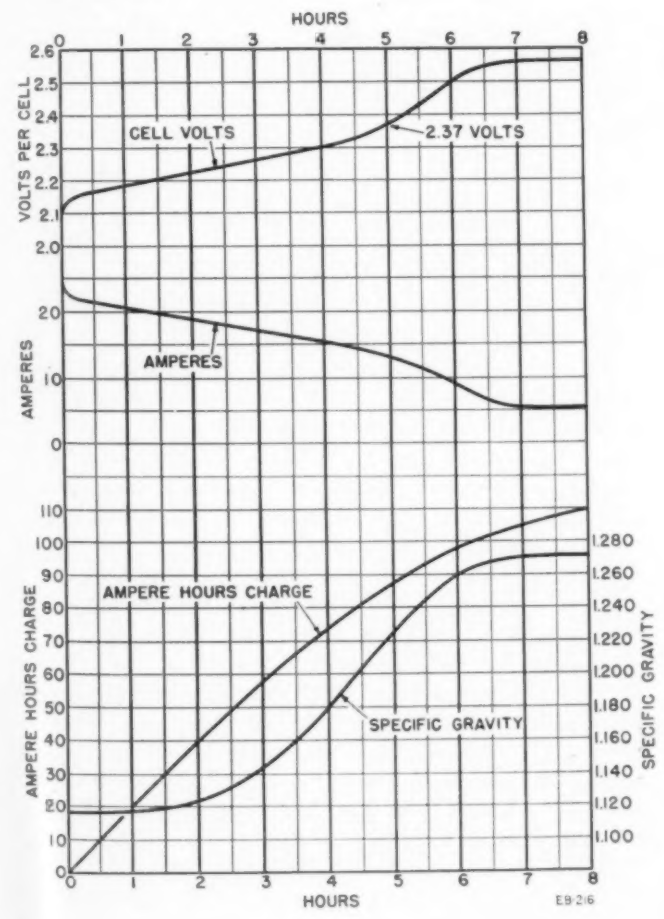
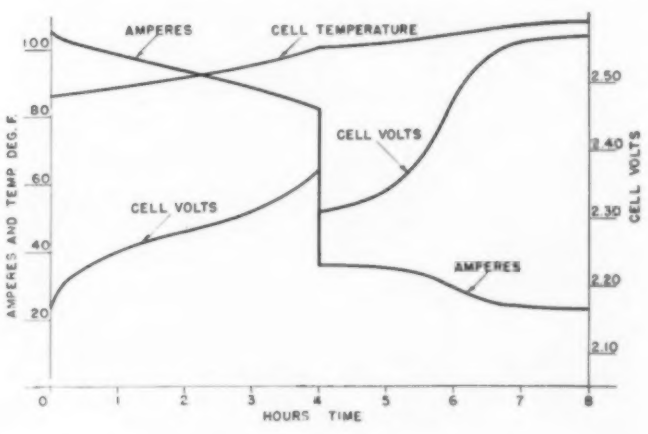


Figure 5 — Chart illustrates a 2-rate charge from a constant voltage bus.



were likewise designed to run slower in the charge direction than in the discharge, and thus took care of the necessary overcharge required by the battery. Ampere-hour meters have several disadvantages. One is that they tend to get "out of step" with the battery, another, that they overcharge the battery on a percentage basis that fails to take into account the total time between charges.

In the late 1920's, F. G. Beetem, assistant chief engineer of my company, came forward with another method of controlling and terminating the charge, based on the principle that the point where the gassing begins and the battery voltage rises rapidly, occurs at about the same state of charge for a given charging rate and temperature. The heart of the control circuit, which he developed, was the temperature compensated, accurate voltage relay, now generally known as the

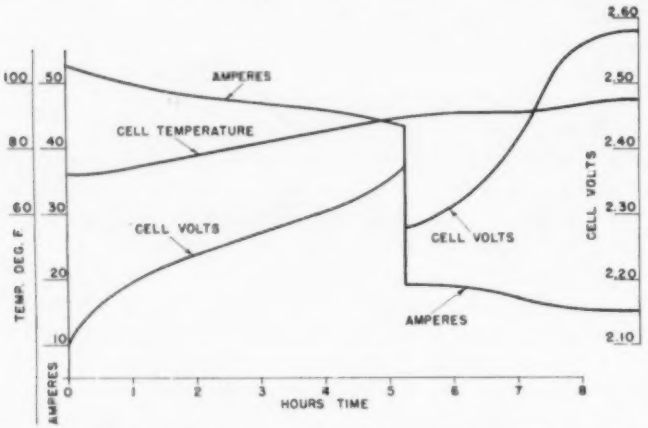


Figure 6 — Chart shows a 2-rate charge from a metallic rectifier.

TVR relay. With modified constant potential charging, the relay functions to start a preset timer which later terminates the charge at the proper point. With the two-rate method, the relay not only starts the timer, but through an appropriate circuit reduces the charging rate to the recommended finishing value.

Currently, whether charging is by the modified constant potential or by the two-rate method, whether by motor-generator or by rectifier, the almost universal control is the temperature compensated relay and time clock combination. In a well known example of this type of control, the voltage relay, the timer and the auxiliary

Figure 7 — Control shown is the usual temperature compensated relay and time clock combination.

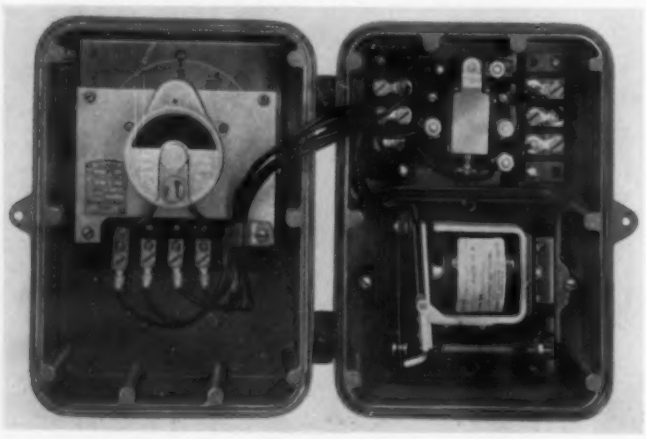


Figure 8 — Control of Figure 7 is here shown in closed position.

relay have all been assembled in a compact case, the control being "triggered" by a simple push button. Figure 7 is a view of the control, opened to show the arrangement of parts. Figure 8 shows control closed and the location of the push button.

Figure 9 shows a control circuit for the usual two-rate charging system. Removal of the second resistor and its related portion of the circuit leaves the standard control circuit for modified constant potential charging. Single circuit motor generators are usually designed for modified constant potential charging and single circuit rectifiers for two-rate. Either method, with voltage relay and timer control, is acceptable from the standpoint of lead battery charging.

Before discussing single circuit chargers, which are subject to more basic design variations than multi-circuit equipment, let us look briefly at the latter. The larger plants are usually made up of several charging units, arranged to be started successively according to charging demands, so that the operation is satisfactory and the efficiency high, whether the plant is operating at 10 per cent or 100 per cent of its capacity. The successive starting and stopping of the various units may be made fully automatic.

All multi-circuit charging plants operate at an approximately constant voltage. Motor generators may be flat-compounded or, by design, inherently constant voltage. With rectifiers, the proper bus voltage is usually maintained by a transformer tap changer which may be automatically controlled by a contact making voltmeter or some similar means. Electronic voltage regulators are also sometimes used.

Both types of direct-current power equipment can

be made completely reliable and both may be used for modified constant potential or for two-rate charging.

Modified constant potential charging is usually preferred when the operating voltage of all the industrial trucks and tractors is the same. With a mixed number of cells per battery in a fleet, and all charging current furnished by the one plant, modified constant potential charging may be applied to the batteries having the greater number of cells, while two-rate charging is required for the batteries having fewer cells. For instance, with a mixed fleet powered by both 18 and 24-cell batteries, the 24-cell batteries will generally be charged by the modified constant potential method and the 18-cell batteries by two-rate.

There appear to be greater differences between the two types of charging equipment when they are designed for charging individual batteries. First of all, to be practical, a single circuit charger must have good regulation over a wide range in output, and when charging a variety of batteries of widely different capacities. One requirement that affects rectifier design, for example, is that variations in a-c line voltage of plus or minus 5 per cent should not cause changes in the finishing rate to the battery of more than 25 per cent. A metallic rectifier could probably be designed with an inherently drooping characteristic which would approximate modified constant potential charging, but it is doubtful whether it would at the same time meet the requirement just mentioned. By using the same design as in multi-circuit work, a modified constant potential characteristic can, of course, be secured but the cost will be high.

A single circuit motor-generator charger can readily be produced which has a modified constant potential characteristic. As mentioned before, however, from a battery standpoint, two-rate charging with voltage relay and timer control, is today just as acceptable as modified constant potential and can accomplish the complete recharging of a battery in the same elapsed time. Under such conditions, motor-generators lose some of the advantages they may have, since rectifiers are admirably suited to two-rate charging.

Differences fade still more when the manufacturers' general specifications for each type of single circuit charging equipment are examined. Common to both are the following:

1. Charger is capable of fully charging "blank" sizes of battery within 8 hours.
2. Charger has an automatic starting device.
3. Charger has automatic means for disconnecting battery in case of power failure and at termination of charge.
4. Charger has fusing (or equal) protection in battery circuit.
5. Charger has overload protection to open a-c line.
6. Charger has d-c ammeter and voltmeter.

The motor-generator set requires a starting control which will hold the charging contactor open until the generator voltage is up to full value. The rectifier chargers are universally fan-cooled and require temperature protection in the event of a fan system failure. Leaving out cost of maintenance, differences such as these tend to balance out.

The discussion thus far has been limited to charging

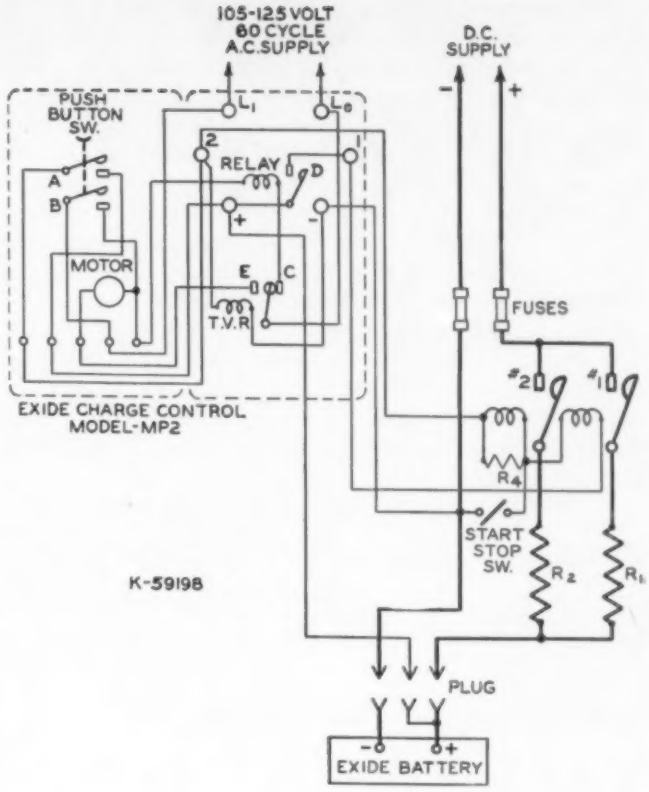
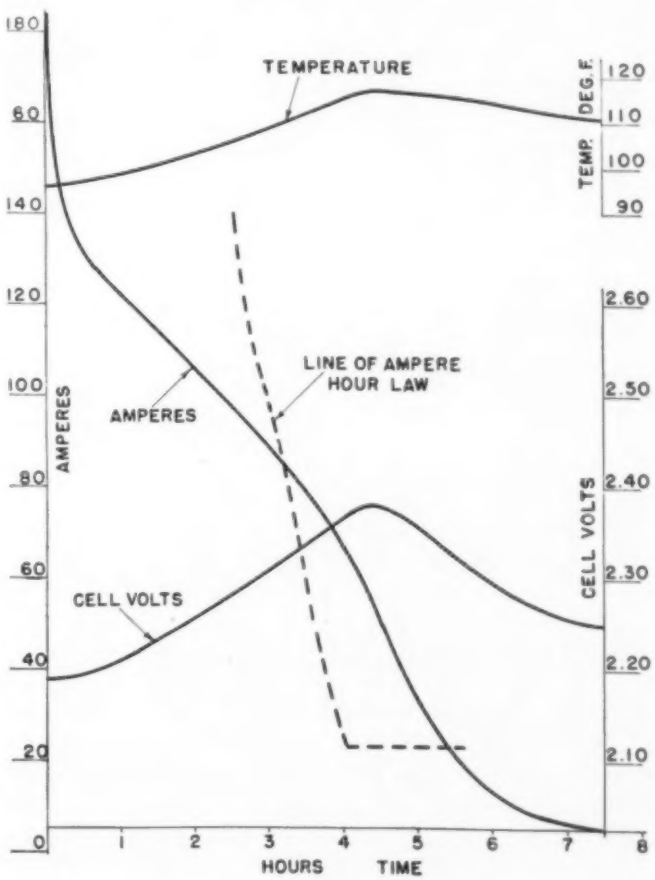


Figure 9 — Control circuit for usual 2-rate charging system.

Figure 10 — Approximation of constant-voltage charge with inherent machine characteristic.



equipment designed around two accepted and standard charging characteristics. Earlier it was mentioned that straight constant voltage charging is satisfactory, but difficult from a charger design standpoint. One manufacturer of rotating equipment recently decided it was possible to design a commercial machine capable of higher initial charging rates and has produced a charging generator with a characteristic much closer to constant potential than the usual practice. The steeply drooping characteristic of this generator is shown in Figure 10. This graph was drawn from a test run to determine whether the temperature of a battery already quite warm would become excessive in the course of the charge. The temperature reached a peak below the danger point, although the charging rate part of the time exceeds the values specified by the "ampere-hour law" of charging.

With this charging equipment, termination of the charge is by overall timer. Thermostat control is also available to shut down the machine in the event of high battery temperatures. The machine will give a good account of itself, if adjusted to the local requirements of the group of batteries it will be used with.

Generally speaking, charging equipment available today does a very commendable job. Whether the conversion of a-c power is by motor-generator set or by rectifier, the results are most satisfactory. Once the purchaser of industrial battery charging equipment has decided what his requirements will be in the way of such equipment, he need only ascertain that the manufacturer is experienced and well established, that the trouble-free service life of the equipment is correctly stated, and that the price is right. From a battery charging standpoint, he should have little concern whether the power conversion is by electronic means or rotating equipment.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, February 23, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Castable Refractories in the Steel Mill," by J. D. McCullough, Chief Engineer, Refractories Division, The Babcock & Wilcox Co., New York, N. Y.

Thomas Jefferson Hotel, Birmingham, Ala.

▲

BUFFALO SECTION

Tuesday, February 10, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"The Fairless Plant," by J. Donald Rollins, Assistant Vice President of Engineering, United States Steel Corp., Pittsburgh, Pa.

Hotel Sheraton, 715 Delaware Ave., Buffalo, N. Y.

▲

CHICAGO SECTION

Tuesday, February 3, 1953 — Dinner 6:15 P.M., Meeting 7:45 P.M.

"Lifting Magnets — Their Care and Maintenance," by A. E. Lillquist, Engineering Supervisor, Cutler-Hammer, Inc., Milwaukee, Wis.

Phil Smidt's Restaurant, 1205 N. Calumet Ave., Hammond, Ind.

▲

CLEVELAND SECTION

Monday, February 16, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M.

Tuesday, February 17, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Industrial Gas Turbines," by S. D. Fulton, General Engineer, Westinghouse Electric Corp., South Philadelphia, Pa.

Cleveland — Coytons Marine Dining Room, 508 W. Superior Rd., Cleveland.

Youngstown — El Rio Club, Youngstown-Warren Rd., Route 422, Youngstown, Ohio.

▲

DETROIT SECTION

Tuesday, February 10, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Ingot Buggy Drive," by A. R. Oltrogge, Steel Mill Division, General Electric Co., Schenectady, N. Y.

Detroit Edison Co. Service Building, Third Ave., Detroit, Mich.

▲

PHILADELPHIA SECTION

Saturday, February 7, 1953 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"Symposium Open Hearth Furnace Availability"

E. E. Callinan, Combustion and Refractory Engineer, Alan Wood Steel Co., Conshohocken, Pa.

Wm. H. Shure, Assistant Supervisor of Maintenance, Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.

H. C. Paxon, Assistant to Superintendent, Refractories and Fuel Department, Lukens Steel Co., Coatesville, Pa.

Engineers' Club, 1317 Spruce St., Philadelphia, Pa.

▲

PITTSBURGH SECTION

Monday, February 2, 1953 — Dinner 7:00 P.M., Meeting 8:00 P.M.

"Pollution Control Can Be Realistic," by John E. Kinney, Sanitary Engineer, Ohio River Valley Water Sanitation Commission, Cincinnati, Ohio.

University Club, University Place, Pittsburgh, Pa.

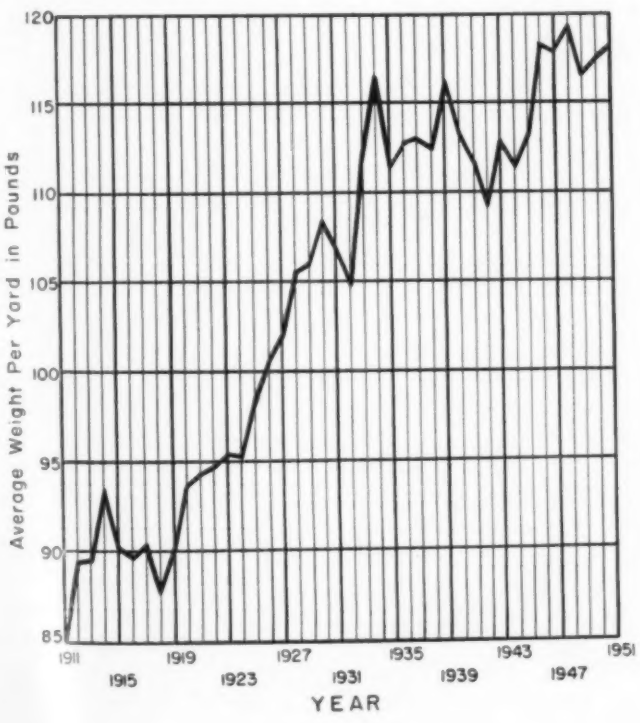
OPERATION AND ROLL DESIGN OF THE GARY RAIL MILL

By R. W. DICKSON
Division Supt., Central Mills
Gary Steel Works
United States Steel Co.
Gary, Ind.

. . . . in operation for over 40 years, this mill is still setting records . . . .

▲ IT seems somewhat unusual that at this time we should review the rolling and pass design of a rail mill first placed in operation in a newly constructed steel plant during February, 1909. After rolling a record breaking annual tonnage in excess of 880,000 tons during 1951, it appears this discussion can well serve as a tribute to those engineers of the steel industry who had the vision and foresight to plan and build a mill which after over 42 years of operation is still capable of breaking tonnage records, and producing rails of section and quality comparable with the best in the industry.

Figure 1 — Graph shows trend of increasing weights per yard of rails rolled at Gary from 1911 through 1951.



The first rails rolled on the Gary rail mill weighed 85 lb per yard, which was the common rail weight at that time. Since that time there has been a trend toward heavier rails to handle the heavier and faster traffic. In 1951 the average weight of rails rolled at Gary works was 118.2 lb per yard. A graphic illustration of this trend, based on the rail tonnage rolled at Gary and representing approximately one-fourth of the total rails rolled in the United States and Canada, is shown in Figure 1. The graph indicates periods of trend reversals, particularly during the war and depression periods.

While a review of the historical changes and improvements from the strap-rail of 1767 to the tee-rail of 1952 is a story in itself, it is sufficient at this point to briefly trace the rail design progress since the Gary rail mill started. This is desirable since many of the mill improvements have been concurrent with design changes. Figure 2 shows a print of section 10020, representative of the earlier sections rolled on the Gary rail mill, and section 11525, representative of the present most popular rail section among the midwest railroads. The last two digits of the section number represent a specific design identification whereas the preceding digits represent the nominal weight in pounds per yard. During the period from 1910 to 1930 there were a large number of rail sections, each having been designed by a specific railroad or an engineering group such as American Railway Engineering Association. Progressive improvements have been made in designs with the most recent occurring subsequent to World War II when section 11525 and several other heavier sections of similar design were introduced. The railroad rail of today, in comparison to the railroad rail of a quarter of a century ago, is characterized by heavier weight per yard, greater top of head radius, and more liberal radii of the head-web and base-web fillets.

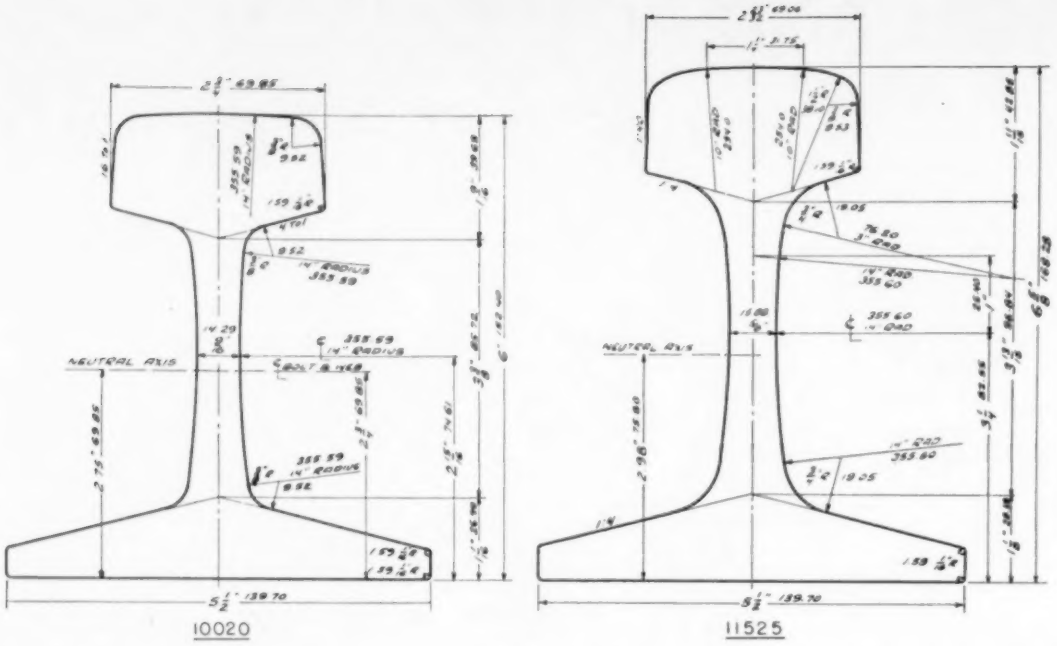


Figure 2 — Comparison of cross sections of old 100-20 and new 115-25 rails.

During the years intervening since the first rail was rolled at Gary, there have been many changes indicative of the progressive steps taken to keep this mill highly competitive and of such interest as to be visited by hundreds of visitors each year. Accompanying the progressive changes in section designs have been more rigid internal and surface quality requirements which have resulted in design changes in mill stands and improvements in rolling practices.

The edging pass in the dummy stand with the head-and-base-wheel rolling technique, which is unique to the Gary mill, and the present adaptability of this mill to the production of a wide range of products, in addition to rails, represent the focal points of this paper.

The Gary rail mill represents one of the three rail mills in the United States which rolls a finished rail direct from an ingot without any intermediate reheating operation. The layout of the mill is shown in Figure 3. This mill consists of a four-stand, 40-in. tandem blooming mill, followed by a three-high 40-in. blooming mill stand with five passes. Auxiliary equipment to the latter includes vertical lifting tables at the front and rear of the stand. One 2000-hp, 214-rpm, 6600-volts, a-c motor drives Stands 1 and 2 of the four-stand tandem mill through a gear reducing drive. Another comparable motor and gear drive is used for Stands 3 and 4. A 6000-hp, 75-rpm, 6600-volts, a-c motor drives the three-high blooming mill. The next facility in progression of rolling is a 10 × 10-in. electrically driven bloom shear used to remove crop ends and cut proper bloom lengths before entry of bloom in the 28-in. rail mill. The 28-in. rail mill consists of a three-high rougher with three passes and is equipped with vertical lifting tables, followed by a two-high former stand, dummy stand, first edger stand, second edger stand, leader stand containing a head wheel when rolling rails, and finisher stand containing a base wheel for rail rolling. The rougher stand, second edger stand and leader stand are in a train powered by a 6000-hp, 83.3-rpm, 6600-volts, a-c motor through pinion and spindles. The former stand is a 28-in. single two-high stand powered by one 2000-hp motor of 58 rpm. The dummy stand, first edger stand, and finisher stand compose the finishing train which likewise is powered by a 6000-hp, 6600-volts, a-c motor of 88 rpm. Transfer beds are located after the dummy stand to the second mill line and after the second edger stand to the third mill line.

Fluted open top ingots 24 × 24 in. and of varying lengths from a minimum of 74½ in. to a maximum of 89 in., depending on the section being rolled, are heated in modern recuperative soaking pits and then delivered to "A" table for movement to the first tandem. Approximately five minutes later, from the time the ingot enters the first stand, the rolling operation will be completed for this specific ingot with the delivery from the finishing stand thereby completing the 18 passes required to produce a railroad rail. Rolls are carried on hand for 23 railroad sections and 3 crane rail sections. Railroad rail sections range from 60 lb per yard to 133 lb per yard, whereas the crane rail sections weigh 105, 135 and 175 lb per yard. During the past two years 18 sections out of a possible 26 sections have been rolled each year.

The direct rolling of ingots to rails without intermediate reheating requires close control of heating and rolling temperatures in order to obtain uniformity of section and produce all rail lengths within the specification requirements. Ingots are heated for a minimum of 4½ hours, regardless of track time which cannot exceed 5 hours, in soaking pits set to control at 2420 F. Uniformity of rolling temperatures are checked by use of a watt-meter on No. 2 stand and a radiation pyrometer ahead of No. 4 stand with the recorders located at the whistle pulpit. A second radiation pyrometer is located on the roller line after the finishing pass with the recorder located near the finishing stand in view of the mill roller. Temperatures ahead of No. 4 stand are within the range of 2050 to 2100 F, whereas web temperatures on the instrument after the finishing stand average 1860 to 1920 F.

The turning of the ingot as it is reduced is handled in such a manner that the bit marks on the ingot are

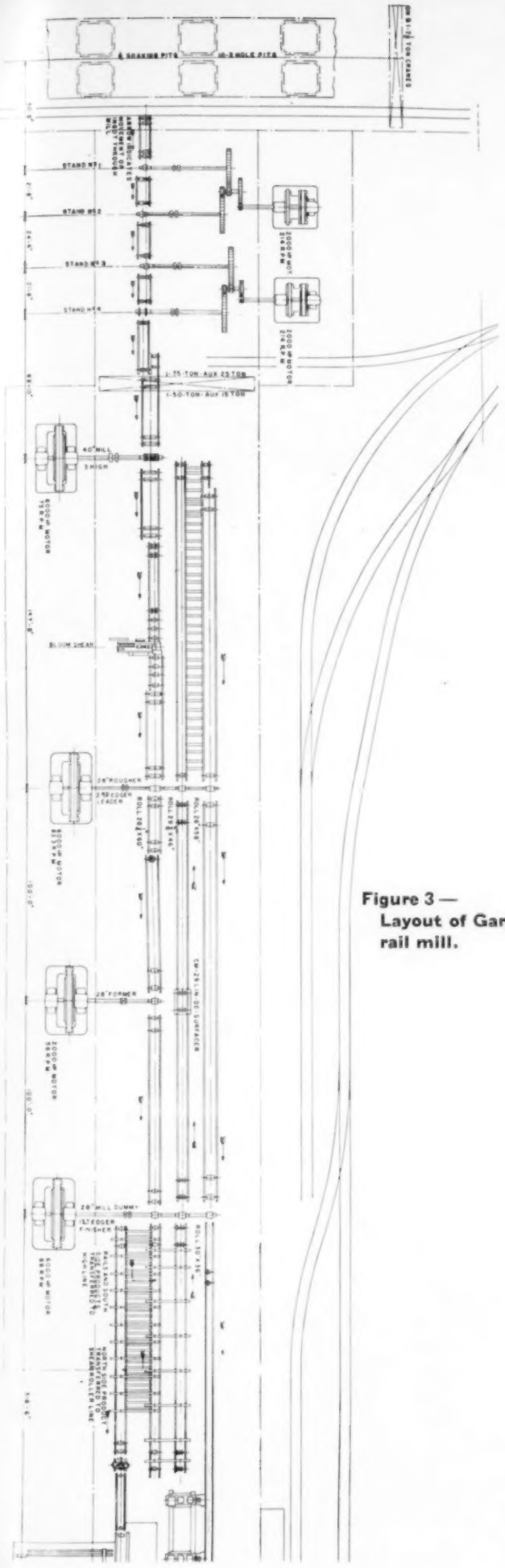


Figure 3 — Layout of Gary rail mill.

located in the web of the finished rail. The first three passes on an ingot are diagonal followed by a box pass in No. 4 tandem (Figure 4). Five passes involving 90 degree turning between passes, except for no turning after the first pass, occur in the 40-in. three-high bloomer. A slightly trapazoidal section approximately $9\frac{1}{8} \times 8\frac{3}{8} \times 8\frac{3}{8}$ in. is produced in the fifth pass of the 40-in. three-high. The bloom delivered from the 40-in. three-high mill is turned 90 degrees and after shearing enters the rougher for three passes. Collared table rolls turn the partially formed bloom delivered from the last rougher pass 90 degrees for entry into the former pass. The five passes after the former pass occur without any additional turning. The revolutions per minute of each stand, delivery speeds and per cent reduction on the 11525 lb per yard rail are shown in Table I. It is to be noted that pass reductions in the 40-in. mill range from a maximum of 28.7 per cent in pass No. 4 to a minimum of 13.8 per cent in pass No. 9.

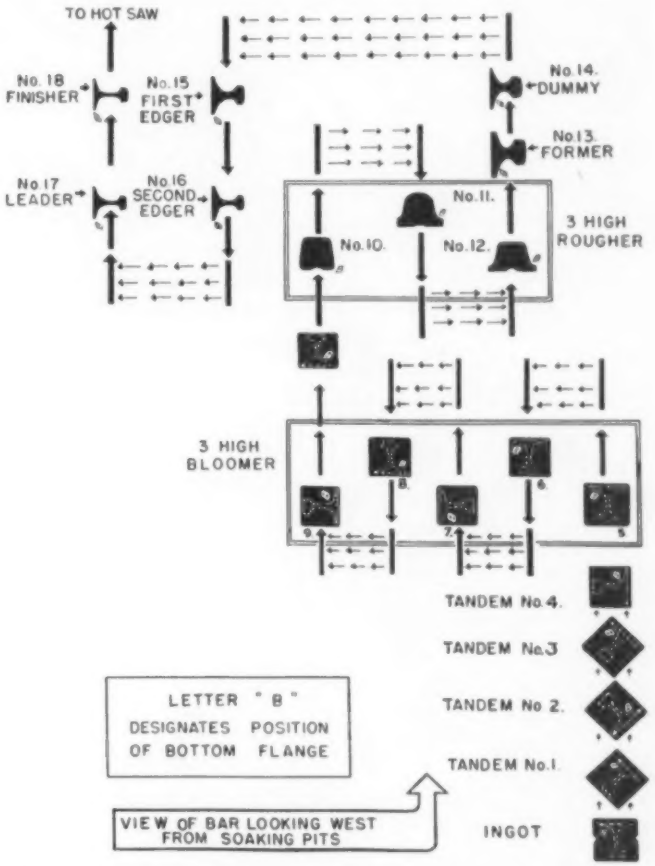


Figure 4 — Sketch shows position of rail in each pass by present rolling method.

Reductions in the 28-in. rail mill range from a maximum of 24.9 per cent in pass No. 10 (first pass of rougher) to a minimum of 8.3 per cent in pass No. 18 (finisher).

Thus far we have indicated the present rolling practice by the new method. At this point we would like to indicate the difference in the present rolling compared to the old style, or old style with modifications, still used on 10 of the oldest sections (Figure 5). Pass designs are comparable until the former stand is reached. Modifications have been made in the former stand so the section from the former can be given an edging pass in the following stand. This is in contrast

TABLE I

Tabulation Showing Revolutions per Minute, Delivery Speeds, and Per Cent Reductions in Each Pass When Rolling Section 11525.

Pass No.	Stand	Revolutions per minute	Delivery speed fpm	Per cent reduction
1	Tandem No. 1	6.3	73.9	14.2
2	Tandem No. 2	6.3	85.8	20.6
3	Tandem No. 3	10.5	121.3	20.3
4	Tandem No. 4	10.5	117.0	28.7
5	First pass, 3-High bloomer	75.0	562.0	17.5
6	Second pass, 3-High bloomer	75.0	634.0	19.2
7	Third pass, 3-High bloomer	75.0	612.0	19.4
8	Fourth pass, 3-High bloomer	75.0	675.0	22.4
9	Fifth pass, 3-High bloomer	75.0	640.0	13.8
10	First pass, rougher	83.3	479.0	24.9
11	Second pass, rougher	83.3	481.0	16.7
12	Last pass, rougher	83.3	523.0	17.6
13	Former	58.0	500.0	20.0
14	Dummy	88.0	675.0	20.7
15	First edger	88.0	684.0	23.0
16	Second edger	83.3	646.0	21.3
17	Leader	83.3	730.0	13.8
18	Finisher	88.0	738.0	8.3

to the base-up position in the dummy stand by old style rolling. Conventional rolling occurs in the first and second edgers. However, the leader pass contains a roller bearing head wheel and the finisher pass contains a roller bearing base wheel in the Gary method which is in contrast to the old style rolling made without use of head and base wheels. Both the head and base wheels are horizontal roller bearing friction driven wheels mounted in a housing which is bolted to the mill

Figure 5 — Sketch compares old and new style rail rolling in 28-in. mill.

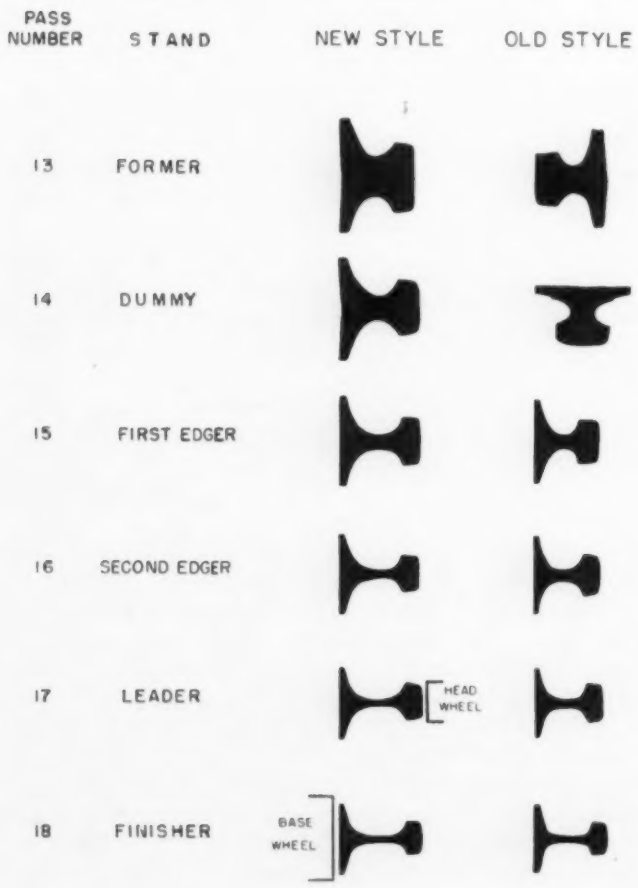
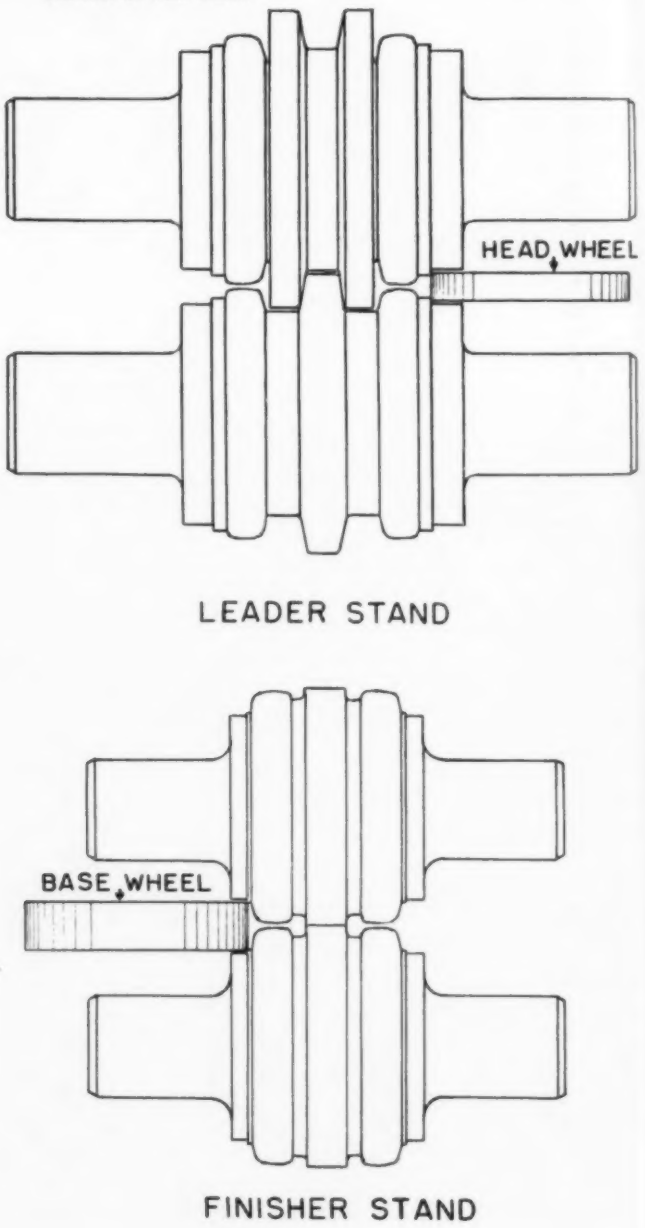


Figure 6 — Schematic roll lay-out of leader and finisher stands of rail mill.



housing. They are lubricated by automatic pressure pumps.

The first experimental rolling using a head wheel in the leader stand was made in 1925. Continued experiments with head wheel in the leader, base wheel in the finisher and edging pass in the dummy stand were made during the next decade. It was not until 1938 that this style of rolling was established as the preferred Gary style of rolling rails. Since that time the new style of rolling has replaced the old style of rolling on many of the old sections and all new sections have been set up for the Gary style of rolling. The ten sections still being produced on the mill by the old method, or old method with modifications, represent sections whose tonnages rolled do not warrant the expenditure to change over.

A sketch (Figure 6) indicates the positions of the head wheel in the leader stand and the base wheel in the finisher stand. These stands have alloy rolls and use composition bearings. Photographs of the leader and finisher stands are contained in Figures 7 and 8.

One of the major changes in the rail mill under discussion occurred in 1935 when controlled cooling of rails was started on a production basis after extensive experimental studies. From the rather crude start with various types of containers and covers, refinements were made and an applicable mill practice was established. Major changes in the entire finishing end processing layout were necessary to economically handle slow cooled product.

Specifications have been prepared by the American Railway Engineering Association so that a uniform controlled cooling practice now is obtained throughout the rail manufacturing industry. Rails intended for railroad service required controlled cooling of the rails within the temperature range between 725 and 300 F. This is a process especially developed to prevent the formation of shatter cracks, also called internal thermal ruptures, flakes or internal thermal cracks.

The controlled cooling practice at Gary involves the use of insulated gondola cars with insulated covers. Rails are transferred to any one of five beds, 50 ft wide by 90 ft long after the gang sawing, stamping and cambering operations. The sixth bed is used to transfer all rails back to a location where lifts, within a temperature range of 1000 to 725 F, which is checked by a radiation pyrometer, can be picked up by magnets and placed in the insulated cars. A thermocouple of the chromel-alumel type is placed between tiers of rails in the slow cool cars in order to obtain temperature readings during cooling. Rails in slow cool cars must meet the specified cooling cycle of not dropping below 300 F in 7 hours for rails 100 lb per yard in weight or heavier, from the time that the bottom tier is placed in the car, and five hours for rails of less than 100 lb per yard in weight. Rails must remain in the slow cool cars for a minimum of 10 hours for compliance with the specifications. In actual practice at Gary, rails average over 24 hours in the insulated cars. Complete records of the cooling cycle to 300 F are maintained on each load.

After completion of the cooling cycle, the cars are transferred to the finishing end pull-in bed for unloading. While cars involve switching charges and high repair costs, there is an advantage of providing a large capacity. At Gary, 150 insulated cars provide capacity for approximately 9000 tons of rails. During the past two years, all rails produced at Gary have been controlled cooled.

The desire to obtain a wider range of products suitable for rolling on the Gary rail mill prompted the introduction of billet and slab sections on this mill in

Figure 7 — Leader stand of 28-in. rail mill.

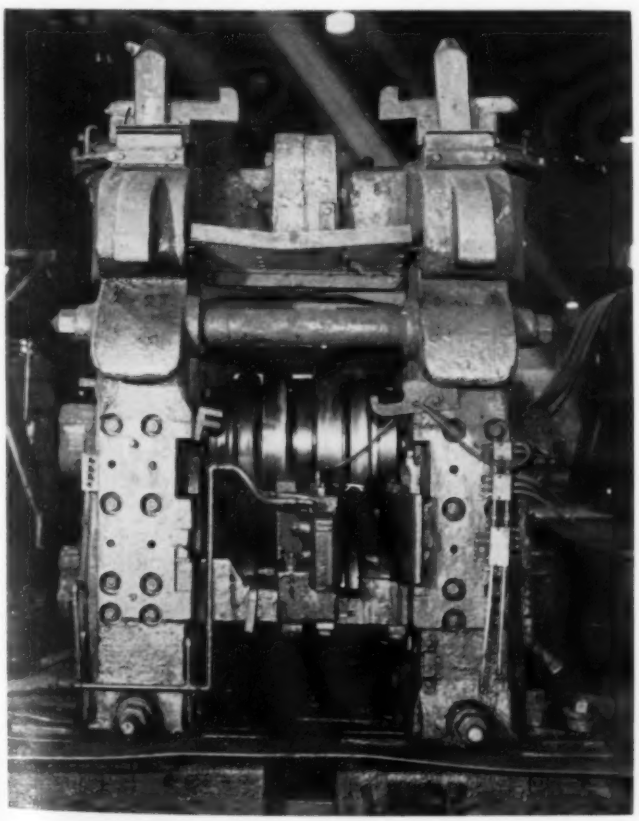
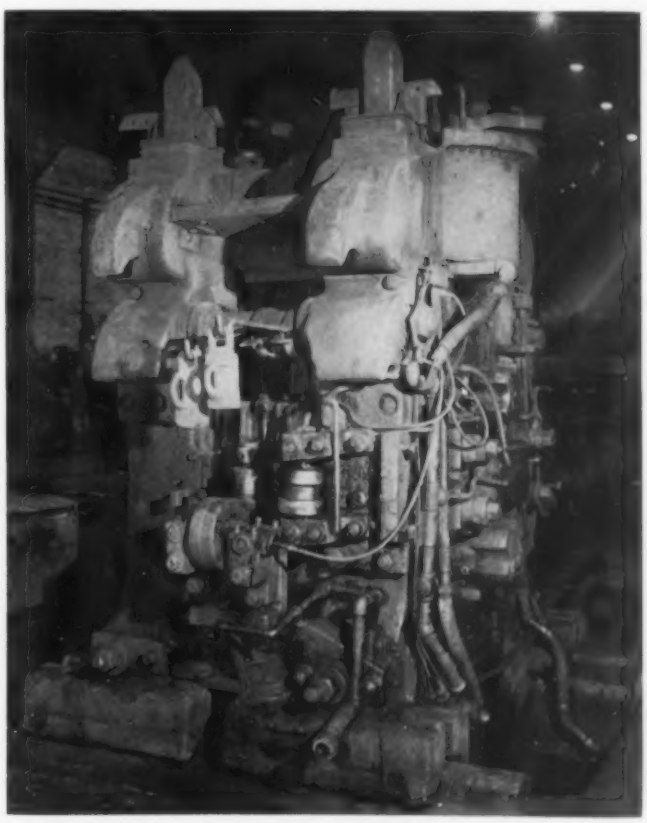


Figure 8 — Finisher stand of 28 in. rail mill.



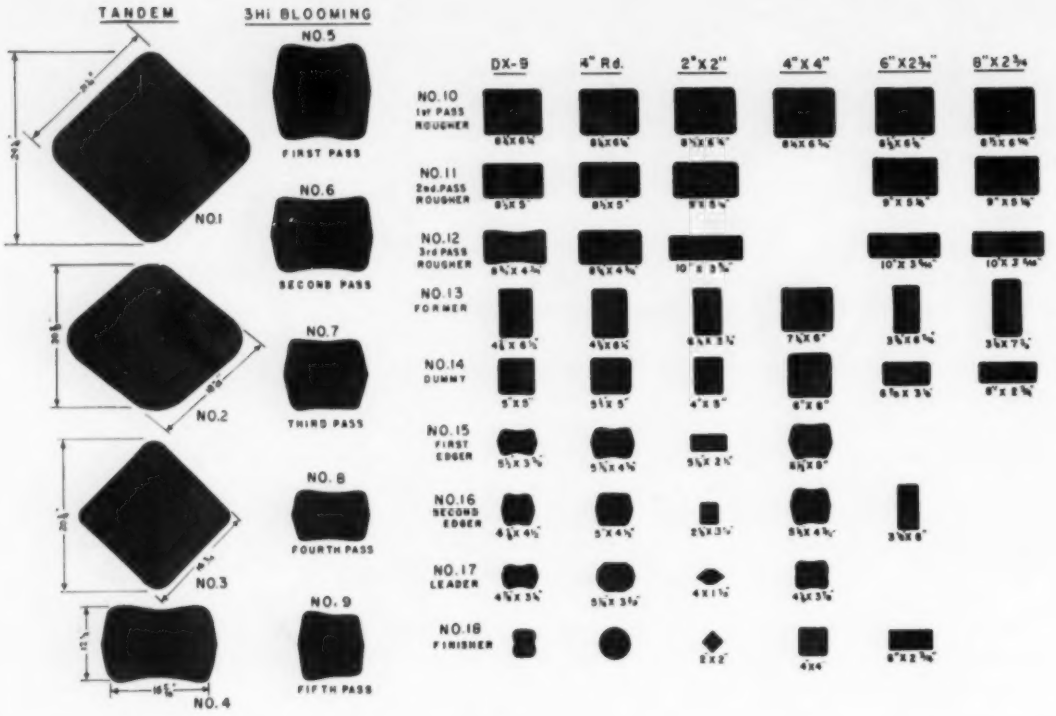


Figure 9 — Pass designs on six products other than rails rolled on Gary rail mill.

the early twenties. These early billet and slab sections were followed by the rolling of special gothic sections, shell rounds and the British bull-head rail during the World War II period. In recent years, tube rounds and die-rolled crankshaft sections have been rolled. The progress of making this mill a combination rail-and-billet mill has been gradual over a considerable span of years. Products other than rails currently exceed half of the total mill production and represents the highest percentage of products other than rails attained to date.

A review of the general lay-out of the rail mill, Figure 3, illustrates the two general practices for products other than rails. Slabs of sizes from 6 × 2½ in. to 12 × 2¾ in. and billets from 5 × 5 in. to 9 × 9 in. are rolled by finishing on the dummy stand and then transferring to a shear approach table where they are moved to a billet shear and then to the cooling bed. The present cooling bed, improved a few years ago, is constructed with cast iron cooling shoes. Billets from 1¾ × 1¾ in. to 4⅝ × 4⅝ in., rounds from 3½ to 5½ in. diam, flats from 3½ × 2 in. to 9 × 2¾ in. and three die-rolled crankshaft sections are rolled through the same stands as used for rails. However, when rolling billets, no head and base wheels are used and some sections do not require all passes. Pass designs on six representative sections of product other than rails — die-rolled crankshaft DX-9, 4-in. diam round, 2 × 2-in. square, 4 × 4 in. billet, 6 × 2¾-in. flat and 8 × 2¾-in. slab, Figure 9, indicate the flexibility of the rail mill facilities. These six sections involve five sections rolled through all stands and one section finished on the dummy stand and using only 14 passes.

It is customary practice to hot deseam the forging and special quality steels with an oxy-acetylene surface removal unit installed in 1944. This machine, which replaced an earlier experimental unit, has been maintained in an up-to-date condition and is very effective in reducing the amount of yard conditioning. The minimum size bar at the machine is 4½ × 2½ in. on which 4 nozzles on top, 4 nozzles on bottom and 2 nozzles on each side are used. The maximum bar at the machine for slabs is 9½ × 2⅜ in. on which 9 nozzles on top, 9 nozzles on bottom and 2 nozzles on each side are used. The maximum bar at the machine for billets is 5½ × 4½ in. on which 5 nozzles on the top, 5 nozzles on the bottom and 4 nozzles on each side are used. Surface metal removal amounts to 1.5 to 2.5 per cent. Tables before and after the scarfing machine are controlled to speeds of 90 to 140 fpm, whereas scarfing is done with oxygen pressures from 30 to 40 psi.

Die-rolled crankshaft billet production represents one of the latest billet sections to be placed on the rail mill. A study of the pass lay-out indicates conventional rolling except in the finisher. The finisher, Figure 10, is a stand containing specially turned passes which during the rolling operation produce the so called die-rolled section. In the case of the crankshaft billet, it means the heaviest cross-section at a point which will ultimately become the throw on the crankshaft. In the case of die-rolling, it is necessary to gear the two finishing rolls together and include a timing disc in order to have the cutting marks diametrically opposite, thus producing the contours of the opposite surfaces in proper relationship. From a beginning with a production averaging 650 tons per turn, rolling practices have been improved to the extent that production for eight hours in excess of 1150 tons has been obtained with average tons per turn now being approximately 950.

One of the major changes made for improving the mill practices in the rolling of die-rolled crankshaft billets was the introduction of a second saw to eliminate a sawing bottleneck. A hot top ingot is provided to produce two blooms, each of which will produce three bars containing ten multiples each. Originally one saw was required to make two cuts on each rolled length. Since finishing and sawing temperatures would affect the location of the cutting mark, the second saw could not be stationary. At Gary this was solved by attaching

the second saw to a hydraulic piston thereby permitting movement. In rolling practice it is now customary to bring the mark to the first saw, while at the same time another operator brings the second saw to the proper mark. Gang sawing is then controlled by the operator of the first saw.

Since the die-rolled section is rolled from a 5 × 5-in. billet from the dummy stand, it is possible to finish 5 × 5-in. billets from this stand when availability of hot top ingots is insufficient to maintain more than three consecutive turns of operation on this one section.

The rolling of rounds have been made on the rail mill for both shell and seamless tube applications. Special dogs on the slightly inclined hot beds are installed to maintain proper cooling and separation during cooling with the result that exceptionally straight rounds are produced. Billets of 2 × 2-in. size are representative of one of the smallest sizes rolled on this mill and normally production of 700 tons per eight hours is attainable. Billets 4 × 4 in. and flats 6 × 2¾ in. are common sizes rolled with average tonnages in excess of 1000 tons per turn. In the case of rolling 4 × 4 in., the practice has been standardized so that this section is rolled from a 6 × 6 in. out of the dummy stand. Thus if a shortage of available hot top steel occurs, the mill can be scheduled with 6 × 6 in. without any delay for section change. Section 8 × 2¾ in. is typical of the sections finished on the dummy stand in various carbon grades, and on which tonnages in excess of 1100 tons per eight-hour turn are common.

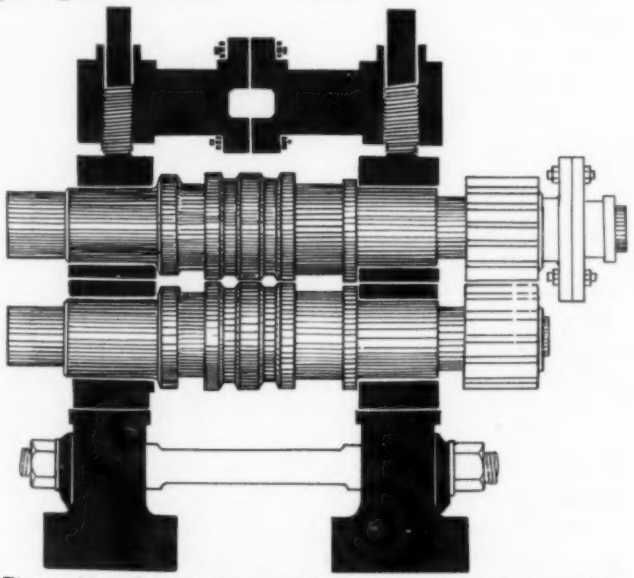


Figure 10 — Sketch shows finishing stand used for rolling die-rolled crankshaft product.

Operation of the rail mill with 4 to 5 different products per week has necessitated close attention to product and section scheduling. In an effort to obtain maximum efficiency of this mill, a 15 turn-per-week schedule has been in practice for several years. This schedule permits a maximum of 8 am to 4 pm and 9 pm to 5 am turns per week, thus affording downtime for roll changes. This schedule was so developed that turns in excess of 15 can be added without disruption of the pattern. The use of this schedule has enabled the mill to keep roll changes to approximately 5 per cent of the operating time. Most of this time is for replacement of worn out rolls.

During the past two years much progress has been made in the reduction of mill delays. In addition to the flexibility obtained on billets previously discussed, all of the rail sections on which heavy tonnages are rolled have a portion of the rougher, former and dummy roll sets with combination rail and slab passes. This arrangement makes it possible to finish slabs in the dummy stand with only a small delay to change passes. In addition to daily reviews of delays for the past twenty-four hours, it is the current practice to maintain charts with the following ten groupings of delays: (1) maintenance; (2) wait for steel; (3) roll change — commercial; (4) roll change — operating; (5) pass change — commercial; (6) pass change — operating; (7) operating adjustment; (8) mill blocked; (9) power; and (10) miscellaneous. Current operating performances indicate that the maximum productive capacity of the mill has not yet been reached.

DISCUSSION

PRESENTED BY

LOUIS MOSES, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

R. M. WEIGEL, Superintendent, Rolling Mill Department, Bethlehem Steel Co., Steelton, Pa.

W. E. DITTRICH, Superintendent Rail and Structural Mills, Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

V. W. JOHNSON, Superintendent Rolling and Finishing, Colorado Fuel and Iron Corp., Pueblo, Colo.

WADE F. HOFFMAN, Superintendent Roll Shops, Jones & Laughlin Steel Corp., Aliquippa, Pa.

EDWARD LAWRENCE, Patent Engineer, United States Steel Corp., Pittsburgh, Pa.

R. W. DICKSON, Division Superintendent, Central Mills, Gary Steel Works, United States Steel Co., Gary, Ind.

Louis Moses: The highly efficient method employed to maintain finished rail heights, flat bases and accurately contoured heads has been proven over many years.

Perhaps a greater interest applies to the truly heavy reductions which are applied to ingot reduction in his continuous blooming mills with their diamond and square groovings. Such amounts of work are given in terms of percentages of reduction, but this does not readily convey to our minds the amounts of metal displacement which occurs. As an instance, as his bloom approaches a dimension of nine in., the percentage of reduction is shown as 13.8 per cent, corresponding to around 13 sq in. of displacement. Contrasted is the first pass on the ingot where approximately the same percentage of reduction corresponds to 82 sq in. Other grooves take up to 102 sq in., etc.

Such heavy work accorded the ingot brings to mind the considerations sometimes occurring in the operations of a conventional blooming mill where relatively heavy or light passes are discussed in relation to imparting or damaging surface quality as well as the effects

to the interior. At the outset, no such reduction could possibly be taken on a conventional blooming mill and only can be so done in total enclosure passes. It seems certain that such relatively large reductions do not harm the interiors in view of the splendid record of Gary rails. Surface quality must be good to pass the truly stringent inspection services of the railroads.

R. M. Weigel: We would like to make a few comments on Gary's method of rolling rails and make a few comparisons with our own mill at Steelton. According to Mr. Dickson's paper, the Gary mill receives a 24 × 24 in. ingot, 74½ to 89 in. long, which has been heated to 2420 F. This ingot is reduced in nine passes to a bloom approximately 9⅛ × 8⅜ in. Pass reductions vary from 13.8 to 28.7 per cent.

At Steelton, our practice is to start with a 26 × 31 in. ingot, 76 to 84 in. long, which has been heated to 2315 F. It is reduced in 21 passes on our blooming mill to a bloom 10 in. × 8½ in. Pass reductions vary from 5.8 to 25 per cent.

Our blooms are then re-heated to 2315 F, and rolled into standard T rails with 10 additional passes. We understand Gary uses nine additional passes after the shears.

We would be pleased to know why Gary prefers head and base wheels when rolling standard T rails. We use a head wheel in the finishing stand, when rolling girder rails and a head wheel in both the leader and finishing stands when rolling guard rails. However, we have never tried them on standard T rails.

In looking over the Gary mill layout, we were impressed with the total motor capacity of 24,000 hp. We were wondering if these motors operate somewhere near a full load. At Steelton our total motor capacity is 13,300 hp. However, this gives us sufficient power to roll at the rate of 100 to 125 tons per hour, depending on the section being rolled.

W. E. Dittrich: Our method of rolling rails at Inland is somewhat different, in that we re-heat and our mill arrangement is entirely different. One of the statements Mr. Dickson made that I would like to comment on is the fact that they are able to keep roll change time to a limit of about five per cent of scheduled operating time. With a mill layout such as described, that is very good performance. It seemed to me a very optimistic estimate of roll change time. I would like to hear something more on that.

V. W. Johnson: I was interested to note, not having seen the Gary mill for some time, they have converted the mill into a mill producing other products besides rails. At Pueblo we have done the same thing.

Our Pueblo plant rolls rails on the initial heat 24 × 24-in. ingot. Like Steelton, we take 21 passes on our bloom mill with 10 more passes in 3-high rougher, 3-high intermediate, and 2-high finishing. We produce about nine hundred tons per turn. We also supply our new rod mill with 4⅜-in. billets. Likewise on that section, we produce around nine hundred tons per turn.

Wade Hoffman: I would like to ask a question. It is not exactly pertinent to rails but more to the mill design and in regard to the side roll. Is it backed up by a back-up roll and what kind of bearings are used for the roll? Many of us not familiar with rail mills would be interested in hearing about straightening the rails and how they are handled on the hot bed. We assume this would be a problem and wondered how it is handled.

Edward Lawrence: I have heard a great deal about the weight of rail, and I have also heard somewhere along the line that 155 lb rail was the heaviest and latest rail. Is there an end in sight as to the maximum weight of rail? In other words, will the railroads go to anything heavier than say an average of 130-lb rail or are some of the railroads considering going to go to rails heavier than 155 lb per yard?

R. W. Dickson: To the comments of Mr. Moses I would like to add that no surface conditioning is permitted on a rail, not even to the extent of conditioning a pinched head by grinding.

All who have been involved in the rolling of steel realize you cannot make a direct comparison of heating temperatures between plants. I commented that Gary set soaking pit temperature controls at 2420 F. The temperature of the ingot entering the first stand is probably 2325 to 2350 F. As rolling progresses there is a cooling effect as indicated by the surface temperature of 2050 to 2100 F at Stand 4.

Our change to the head and base wheels and the edging pass in the dummy was due to our difficulties with seams in the center of the base. Our experimental work progressed on these three changes concurrently with modifications being involved as progress was made. Many problems occurred which required solutions, such as the metal flow problem related to the base wheel reductions. Now, we purposely upset the metal with the head wheel so as to get satisfactory flow in the finisher without laps. Upsetting is done to the extent of producing a "ball" effect, thereby precluding the formation of laps experienced during the development period.

The base wheel in the finisher gives Gary a very flat base. The present practice of rail rolling at Gary eliminates any location where seams in the center of the base are likely to form.

There is one motor loaded to capacity when rolling billets. Heavy reductions in the former stand when rolling billets loads the 2000-hp motor for that stand to capacity. The other five motors have ample capacity for the reductions presently being taken on the mill.

In regard to the low roll change time, we feel the largest factor involved is the staggered-15-turns-per-week schedule which is followed. The rail mill operating schedule is purposely built up so the maximum number of roll changes can be made during scheduled down periods. An illustration of how well that works is indicated by production of 1200 to 1300 tons on staggered eight-hour turns compared to 900 to 1000 tons per turn when rolling consecutive turns. Frequently on scheduled down periods, rolls are changed before they are completely worn out, which is felt to be economical in order to keep the mill rolling on scheduled operating turns.

Another contributing factor to low roll change down time is the fact we have replacement stands. For example, the rougher has two stands for rails and one for billets. There are two rail stands and one billet stand for the leader. The finisher has two rail stands, two billet stands and one extra heavy stand for die-rolled crankshaft billet rolls. The latter was necessary since our standard stand would not withstand die-rolling.

Louis Moses: Is that finish stand variable speed?

R. W. Dickson: No, it is constant speed. In answer to Mr. Hoffman's query relative to side rolls, I can only generalize and say side rolls on primary mills do not have back up rolls. Side rolls have various types of bearings.

In reply to the question relative to straightening of rails it appears advisable to start at the cambering machine. This machine, located after the saws, cambers the rail while hot so the rail when cold will be reasonably straight. This operation is necessary because of the non-uniform cross-section of the rail. Rails are placed on hot beds for cooling to 1000 F during which time it is Gary practice to turn each rail once. After the slow cooling cycle is completed, the rails are removed from the car and transferred to the straightening presses for gag straightening. Gary endeavors to camber the hot rail to the extent that the cold rail, in a head up position before straightening, will be lower in the middle than on either end. This is done so the straightening work in the gag presses will be on the base rather than on the head. Gag straightening is fundamentally a manual operation, and is essentially the same throughout the United States and Canada. Machine straightening is done in Europe where lower chemistry rails are manufactured. Gary has machine straightened one heat of rails and now is following the service life which thus far has been satisfactory.

To the inquiry relative to the ultimate maximum size rail, I can only say that eastern mills are rolling regularly 140 and 155 lb per yard railroad rails. Gary has had inquiries from a midwest railroad for a rail over 150 lb per yard in weight, indicative of the interest in heavier rails which have an advantage of reducing maintenance costs. What the ultimate limit will be is difficult to forecast. The present maximum railroad rail weight is 155 lb per yard. Crane rails are currently being produced up to and including 175 lb per yard.

AID DEFENSE

MORE SCRAP TODAY . . . .

MORE STEEL TOMORROW.

GET IN THE SCRAP TO KEEP STEEL COMING.

NON-FERROUS SCRAP IS NEEDED TOO!

BASIC FACTORS IN ELECTROLYTIC CORROSION

By E. F. WOLF
Superintendent Electric Test Dept.
Consolidated Gas Electric Light and
Power Co. of Baltimore
Baltimore, Md.

. . . . corrosion is best eliminated in the design stage through choice of materials, location, or suitable protective measures . . . .

▲ THE fundamental principles of electrolytic or electrochemical corrosion are relatively simple, but the application of these principles to a specific case may be quite complex. In this paper we can do little more than review some of the simple fundamentals. Most engineers have undoubtedly studied these fundamentals in introductory courses in chemistry, physics and electricity, but each time we review these basic laws we are apt to find that they have a richness of meaning which has heretofore escaped us.

Two essential conditions necessary for electrolytic corrosion are obvious. First, there must be a source of potential and, second, there must be a conducting solution to serve as the electrolyte. In underground corrosion the moisture in the earth provides the conducting solution. There are four principal sources of potential, namely; (1) external potentials or stray currents, (2) unlike metals connected with each other in contact with the soil, (3) differences from one point to another along the same metal, and (4) differences in the solutions in contact with the same metal.

Corrosion caused by external potentials or stray current is the type which is most commonly called electrolytic corrosion or electrolysis; but it is not essentially different from the corrosion caused by locally generated sources of potential, except that the voltage and magnitude of current may be much greater than in the cases where the voltage is generated by local cell action. Stray current corrosion is more likely to be encountered in urban areas or near heavy industrial operations. The direct current electric transportation system is well known as a source of stray currents, but electric welding and electroplating operations may produce serious stray current troubles in local areas.

The sources of self-generated voltage are often much more difficult to locate than the sources of external potential. Different metals in underground structures may produce voltages of as high as a half a volt or more. The current-producing capacity of such cells is usually very limited but sufficient to produce local destructive action.

One of the common cases of such cell action is the contact of carbon particles from cinders with metallic surfaces. I am familiar with one case of corrosion of lead-sheathed cables laid across a stream of brackish water where the corrosion was caused by fine coke particles which floated down a stream and settled on the cables. At each point where a carbon particle contacted the lead, a cell of approximately 0.5 of a volt was generated in the presence of the brackish water.

Figure 1 — Sample of lead buried in bed of stream for 3 months shows pitting at points of contact with coke particles.

Localized pitting took place and caused a succession of failures (Figure 1.) This was a type of trouble which was difficult to identify and expensive to correct. An insulating protective coating was the remedy.

Cell action due to differences in composition of liquid in contact with the metal is also often difficult to locate in underground structures. These so-called concentration cells are generally not as well understood as the other kinds of local cells. Voltages are generated whenever a metal is in contact with two different kinds of solutions, different concentrations of the same solution, or different concentrations of dissolved oxygen in the solution. This latter case is commonly called differential aeration. The potential of any electrode in contact with a solution depends on the nature of the elements itself and on the concentration of the ions of the element in contact with the surface. This may be represented as shown in Figure 2 by the equation:

$$E = E_o + \left(\frac{0.059}{N}\right) \text{Log } C$$

where E_o is characteristic of the element itself and C is the concentration of its ions. If a metal is in contact with solutions of two different concentrations at different points, the voltage which will be generated by the local cell will be equal to the difference of the potentials at the two points. This difference may be represented as shown in Figure 2 by:

$$E_1 - E_2 = (E_o + \frac{0.059}{N} \text{Log } C_1) - (E_o + \frac{0.059}{N} \text{Log } C_2).$$

This is equal to $\frac{0.059}{N} \text{Log } \frac{C_1}{C_2}$. For bivalent metals, this is equal to $0.029 \text{ Log } \frac{C_1}{C_2}$. Therefore, if the ratio of concentrations is 10 to 1 the voltage is 29 millivolts. This may appear to be a trivial voltage but in fact it is quite significant. For instance, if the solubility of the metal compound is dependent upon the alkalinity of the solution, a difference of 4 pH units at two points along the metal will theoretically give rise to a voltage of approximately one-fourth of a volt.

FACTORS INFLUENCING SPEED OF CORROSION

After one discovers the source of the voltage, the next question is how fast will corrosion take place. In the very early days of chemistry, Faraday discovered that the amount of metal carried into solution by electrolytic action was directly proportional to the magnitude of the current, the length of time the current flows, the atomic weight of the metal, and inversely proportional to the valence of the element. According to Faraday's law, one ampere can remove 20 pounds of iron a year. There is just one complication to this otherwise simple fundamental law. This law assumes that no other electrochemical reactions are taking place on the surface of the metal, but in actual practice usually several secondary reactions take place in addition to the corrosion of the metal under investigation.

Since the rate of corrosion for any given metal is

I EXTERNAL OR STRAY CURRENTS

II TWO UNLIKE METALS

III DIFFERENCES WITHIN METALS

IV DIFFERENT SOLUTIONS IN CONTACT WITH METAL

- A. DIFFERENT CONCENTRATIONS OF SAME SOLUTION
- B. DIFFERENT SUBSTANCES IN SOLUTION
- C. DIFFERENT CONCENTRATIONS OF DISSOLVED OXYGEN

$$E = E_0 + \frac{0.059}{N} \text{ LOG } C$$

$$E_1 - E_2 = (E_0 + \frac{0.059}{N} \text{LOG } C_1) - (E_0 + \frac{0.059}{N} \text{LOG } C_2)$$

$$= \frac{0.059}{N} \text{LOG} \frac{C_1}{C_2}$$

FOR BIVALENT METALS

$$E_1 - E_2 = 0.029 \text{ LOG} \frac{C_1}{C_2}$$

Figure 2 — Voltage which causes corrosion in underground structures may come from a number of sources.

primarily dependent upon the magnitude of the current, we are next interested in determining how much current will flow under a given set of conditions. The amount of the current is determined by three factors. First, the magnitude of the voltage, second, the electrical resistance of the circuit, and, third, the opposing force at the surface of the metal. This opposing force at the surface of the metal may be a high resistance film formed on the metal, or it may be a back electromotive force produced by the electrochemical reaction itself.

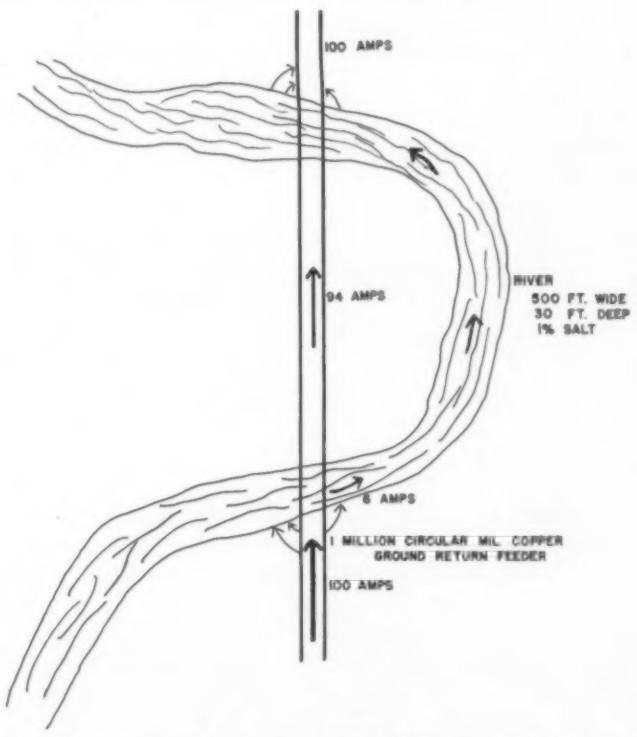


Figure 3 — Surprisingly enough, a river may act as a conductor.

It is a well-known fact that relatively high electrolytic potentials sometimes exist for many years with very little corrosion. The really serious troubles occur when we have the combination of a high driving force and low resisting action. With a combination of appreciable

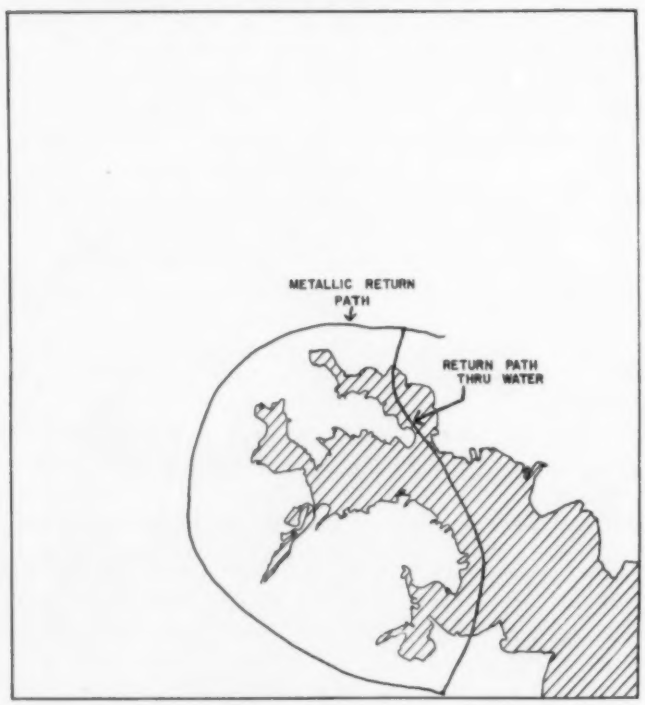
voltage, low soil and low contact resistance, and the absence of opposing forces at the surface, we have real trouble. If any one of these three conditions is not present, the amount of the corrosion may be small. This is the saving fact which permits many familiar uses of metals.

The tendency of a metal to polarize or not polarize is often unpredictable; but success or failure of an unprotected underground structure may well depend upon this factor. For instance, in a pure 5 per cent sulphuric acid solution, a lead structure may show little or no corrosion after a year with an applied voltage of as much as 0.8 of a volt. In a 0.05 per cent solution, electrolytic corrosion will occur at the water line, but in a 0.005 per cent solution with the same applied potential, corrosion takes place rapidly. The difference is in the degree of polarization. With the more concentrated solution, a back voltage is produced at the anode almost equal to the applied voltage, and this prevents the flow of any appreciable amount of current. Similar fortunate circumstances often permit the existence of underground or underwater structures in what seems to be extremely bad environment. With the dilute solution, the surface does not polarize and corrosion occurs.

The next question which we should consider is the path which stray current will follow. We are all familiar with Ohm's law, but we are apt to forget that it applies rigidly to corrosion problems. Stray currents divide among all possible paths in proportion to their respective conductivities. For instance, appreciable amounts of return current from grounded rails of electric transportation systems return to the source over parallel paths of many miles in length. Metallic underground structures are the more obvious paths, but there are two other common paths which are less obvious. One of these is brackish water. The flow of return currents through tidal rivers and estuaries in industrial areas may be illustrated by Figure 3. For instance, if a 1,000,000-circular-mil copper conductor is provided as a ground return path for 100 amperes and this conductor parallels a brackish river 500-ft wide and 30-ft deep, the wire may carry only 94 amperes and the river 6 amperes. The structures which conduct the current to the river may suffer severe corrosion.

Another and still less obvious path for return ground currents is the a-c transmission or distribution circuit in a large industrial plant. The high voltage a-c circuits may provide good low-resistance paths for low-voltage d-c currents from one ground point to another within the plant as illustrated in Figure 5. The only limiting factors to the flow of the d-c current are the d-c resistances of the transformer windings and other circuits, which are usually very low.

Figure 4 — Current may split and go through a metal conductor and through a brackish bay or inlet.



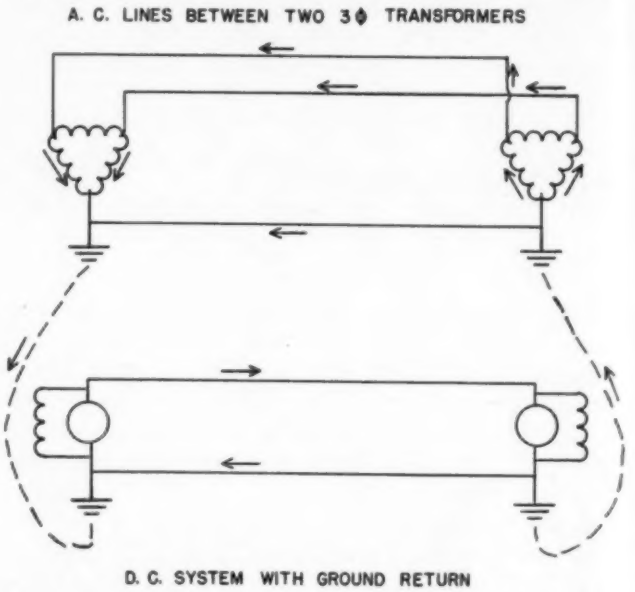


Figure 5 — Even a transmission line may provide a path for stray circuits.

PREVENTION OF CORROSION

Now that we have considered the causes, the real point of interest is prevention. The best time to prevent corrosion is when the structure is in the design stage, while there may still be an opportunity to eliminate some of the causes by choice of materials, choice of location, and choice of suitable protective measures.

The two most favored methods of underground corrosion protection in recent years are heavy insulating coatings and cathodic protection, or a combination of both. Cathodic protection has come into widespread use only in the past fifteen years.

CATHODIC PROTECTION

The principle of cathodic protection is simple. An effort is made to cause sufficient current to flow onto the structure to neutralize or off-set the current which otherwise tends to flow off. This may be stated in another way. In cathodic protection, a potential is applied to the structure of sufficient magnitude to overcome the local or stray potentials which are causing

corrosion. As a general rule, it is found desirable to keep the protected structure about 0.25 volts negative, or cathodic, to the surrounding soil or water.

Cathodic protection requires the continuous application of voltage. In order to apply this voltage, masses of metal or carbon electrodes must be buried in the ground or water. Current is introduced into the soil through these buried anodes and returned through the protected structure. These metal anodes are corroded away sacrificially by the current. For this current to serve its purpose, it must spread out and distribute itself along the structure to be protected. The amount of current required may vary from 0.5 to 20 milliamperes per sq ft of exposed surface. The actual amount of current required to produce the desired negative potential on the protected structure must usually be determined by field tests.

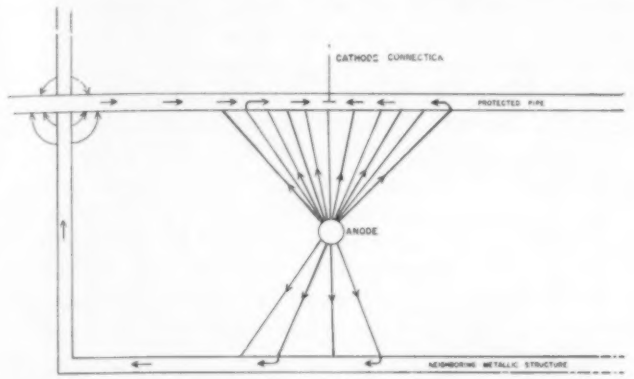


Figure 6 — Careful consideration must be given in the design of cathodic protection to neighboring structures.

Three sources of potential are commonly used to produce cathodic protection, namely, motor-generator sets, rectifiers and local cells. Three metals are available for these local cell anodes, namely, zinc, magnesium and aluminum. Zinc has been used for many years for anodic protection. Since the war, magnesium, which produces a higher negative potential than zinc, has been promoted quite actively for this purpose. Where the area to be protected is extensive or the required voltage or current is high, an external source of potential from a rectifier or a d-c generator is usually required. The active metal anodes are principally applicable where the area to be protected is more localized or the required voltages and current are relatively low.

In the application of cathodic protection, precautions must be taken to avoid excessively high negative potentials and also to avoid damage to other underground structures. If the potentials are too high, alkaline deposits may be formed on the surface of the metal and hydrogen gas may be liberated. Alkaline deposits produced by excessive cathodic protection may in turn produce corrosion, particularly on such metals as lead and aluminum. The alkaline deposits and hydrogen gas may also tend to destroy protective coatings.

The possible effect of cathodic protection on other structures is illustrated by Figure 6. If other metallic structures are in the vicinity of the protected structure, a portion of the applied current may be picked up by these other structures and be returned at some other location to the protected structure. At the point where current leaves the neighboring structures, severe damage may be produced. Careful consideration should be given to the effect of cathodic protection on such neighboring structures. In most cases it is necessary to bond these structures together with connections of suitable resistance. Trouble may be minimized by keeping the required current low by the use of insulating coatings on the protected structure. Also the closer the electrodes are spaced to one another and to the protected structure, the less trouble will be experienced from current following other than the intended return paths. If the structure to be protected is extensive and uncoated, the amount of current required for complete protection may be excessive. To avoid undesirable effects on other structures, it may be necessary to compromise at less than the amount of current needed for complete protection. In any event, where cathodic protection is applied, its effects on the potential of the protected structure and on neighboring structures should be checked by repeated field measurements. I emphasize the need for repeated field checks since equilibrium voltages are not established immediately because of polarization effects.

Cathodic protection is a valuable tool and should not be abused or used selfishly. It should be applied with due consideration to the interests of all owners of underground or grounded structures. Recommended procedures to be followed where nearby structures are owned by several parties are contained in the report of the Correlating Committee on Cathodic Protection, which was published by the National Association of Corrosion Engineers in 1951.

DISCUSSION

PRESENTED BY

HARRY H. ANGEL, Electrical Engineer, Construction and Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

JOHN W. DEIMLER, Sales Engineer, Towle & Son Co., Philadelphia, Pa.

L. V. BLACK, Superintendent, Electrical Dept., Bethlehem Steel Co., Bethlehem, Pa.

L. F. COFFIN, Assistant General Manager, Bethlehem Steel Co., Sparrows Point, Md.

H. H. Angel: I do not think that the majority of people realize just how corrosion exists in everyday use, with its attendant amount of destruction every year.

The other day I read an article on the subject and learned that one writer estimated about $5,000,000,000 are consumed every year to protect against corrosion and in the damage done where protection may or may not have been practical.

I remember hearing an engineer from a pipe line company with headquarters in Philadelphia discussing costs of protecting the lines. One line installed in the Philadelphia area had been provided with insulation, but when the joints were welded, no insulation was used for same, resulting in leaks sometime later. The cost of providing cathodic protection, due to the cost of land and power necessary, was about $9000 per mile for the

initial mileage, but somewhat less for subsequent installations. Power cost was over $2000 per mile per year.

I would like to ask Dr. Wolf if he could mention a few installations in the Baltimore area where protection has been provided.

John W. Deimler: We have installed cathodic protection, with the magnesium rods planted in our various substations and other areas throughout the plant. There is one point that I would like Dr. Wolf to possibly elaborate on a little more, that is, the return circuit through high-voltage a-c circuits and what preventive measures might be taken to prevent it.

L. V. Black: I am interested in Dr. Wolf's comment on welding machines. We have had some trouble with electrolysis in one of the boiler houses at the Bethlehem plant and considerable time was spent trying to find the source of stray currents. On occasions a number of welding sets are operated in the location of the boiler house, and probably these units added to the electrolytic troubles. I would appreciate more information on this.

L. F. Coffin: We have difficulty at Sparrows Point where we pump salt river water with graphitization on the inside of our large cast iron salt water lines, particularly in those pipes after the salt water has been heated — by passing through surface condensers. Core borings in some cases show graphitization of ¼ to ⅜-in. thick. This is believed to be a form of electrolytic corrosion. I would like to ask Dr. Wolf to elaborate as to the particular type of insulating coatings, which are effective on the cast iron and steel pipes.

F. F. Wolf: Mr. Angel asked about examples of cathodic protection in the Baltimore area. The first example of cathodic protection with which I am acquainted was applied at one of the electric generating stations where there was a tendency during certain periods of the day for d-c current to return through water-front structures to the harbor water, and back to the source several miles from our generating station. In that case, large sheets of steel were placed in the water off shore and potential was applied by means of a rectifier. This application was developed nearly twenty years ago. At that time we looked upon this procedure as providing a means for forcing the direct current to flow off through the steel plates instead of through the vulnerable underground structures.

There are a number of places in Baltimore where cathodic protection is applied to the underground cable system. I also understand that communication cables between Baltimore and Washington have cathodic protection applied by means of rectifiers.

We have also had a question of how d-c current can return to its source through high voltage a-c circuits. The windings of transformers have relatively low d-c resistance. If the transformers are connected with a wye connection with the neutral grounded or with a delta connection with one corner grounded, it is possible for the stray current to go from earth through the transformer windings and over connecting lines to any other grounded point on the system. In the case of alternating currents, the flow of current in such a circuit is limited by the a-c impedance, but the flow of d-c current is limited only by the d-c resistance of the circuit. In the case of ungrounded electric circuits in industrial plants this problem does not arise. The principal means of controlling the flow of return current is to provide good low-resistance metallic circuits so that a minimum of current will find its way back through extraneous paths.

There was some discussion of welding as the cause of electrolytic corrosion. From time to time, d-c welding operations actually cause such troubles. This may be particularly true if the source of the direct current is on land and the welding is done on shipboard, and the current is allowed to find its way back from ship to shore through the water.

One of the speakers asked about the use of insulating coatings. This is a very highly specialized commercial field. A number of these coatings have been developed in recent years and some have very high electrical resistance. At the present time, it appears that they offer a very considerable amount of protection and appreciably reduce the burden placed upon the cathodic protection system. I would not be in a position to discuss any particular type of protective coating.

ANALYSES OF OHIO COALS NOW AVAILABLE

▲ OHIO, one of the principal bituminous-coal-producing states since the late 1830's, has produced more than a billion and a half tons of coal from the date of the earliest record to the end of 1948, according to a bulletin released by J. J. Forbes, director of the Bureau of Mines, Department of the Interior. Although large, this tonnage is only a scratch on the surface of the Buckeye state's tremendous reserves, which have been estimated at almost 94,000,000,000 tons.

The bulletin, "Analyses of Ohio Coals," is one of the Bureau's series containing analytical data on the composition and quality of coals for the separate states or, if production is small, by groups of adjacent states. A revision of Technical Paper 344, released in 1923, it is the first of the series to be reproduced in bulletin form.

The Ohio analyses include principal facts regarding reserves, characteristics, production and uses, as well as concise discussions of the economic position of the state's coal industry and the trend of development in recent years, and data not previously published.

In 1948, production from 697 commercial-size Ohio mines totalled 38,708,278 tons valued at the mines at $155,220,000. Distribution figures for 1946 show that railroads are the largest single consumer of Ohio coal, followed closely by general industrial users, with only about 7 per cent going for retail and domestic use.

Copies of Bulletin 499, "Analyses of Ohio Coals," may be obtained from the superintendent of documents, United States Government Printing Office, Washington 25, D. C., at 50 cents a copy. The publication is not for sale by the Bureau of Mines.

FUNCTIONING OF A LUBRICATION ORGANIZATION IN HEAVY ROLLING MILLS

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United States Steel Co.
Gary, Ind.

. . . . the lubrication organization described here improved lubrication practice which resulted in cost savings and better working conditions . . . .

▲ THE purpose of this paper is twofold; first, to show the existing need and value of a well-organized lubrication organization in the steel industry; and second, to emphasize the important fact that this lubrication organization must function properly to be of value. In order to explain and illustrate the subject in a methodical manner, the author has chosen a heavy rolling mill division of a large steel plant as a typical example. This typical division, which is to be used as an example, consists of two blooming mills, a slabbing mill, a billet mill, a rail mill, and a plate mill. This combination of mills will cover representative lubrication problems that will be encountered in the steel industry.

Extreme heat, excessive cold, and many other adverse conditions must be met by the machinery in such a division. Therefore, any lubrication organization set up for this division will function, for any steel plant or portion of a steel plant, by adapting the size of the organization to the size of the division or steel plant.

Many steel companies have become lubrication-conscious to the extent that much up-to-date lubricant dispensing equipment has been installed, good lubricants have been stocked, and lubrication engineers hired. But in too many instances a closely knit lubrication organization and the proper functioning of such an organization are still lacking, or perhaps complete cooperation with other plant organizations is lacking.

The initial cost of lubricant dispensing equipment is high. However, when this equipment is properly maintained and good salvage practices effected, the lubricant dispensing equipment will pay for itself. Better grade lubricants are naturally more expensive, but an increase of a few cents per pound for a lubricant that will show a reduction in maintenance costs of many cents per ton of steel rolled, is a very good investment.

Before delving into the organization of the typical steel mill unit, the author will show how lubrication practices have advanced in steel plants, and some of the trials and tribulations that were encountered along the way.

Most of the steel mills were built in the early part of the twentieth century, while a few plants have been erected in the past few years. Prior to World War II the lubrication practices of steel mills, as a general rule, were crude. The older type equipment was lubricated manually by means of an oil can, manually applied grease or grease cups. This practice resulted in about 20 per cent of the lubricant reaching the desired bearing surface and about 80 per cent of the lubricant reaching the floors, sewers, and other useless places. Labor crews were occupied in cleaning up this excess lubricant. Maintenance men encountered this excess lubricant when performing necessary repair work.

In the more modern mills, lubricant dispensing equipment has been installed. However, these systems, if not properly maintained, soon become defective and inoperative and have been replaced by the old method. In other words, in many older steel plants lubrication organizations have been lacking, and lubrication practices and equipment used are obsolete.

When World War II became a reality, our government realized that to preserve our way of life, our country must produce the greatest military force that was ever created. The steel industries were called upon to produce steel in tremendous quantities to furnish equipment for what was to become the greatest fighting machine of all time. This steel had to be produced primarily in existing steel plants, since there was not enough time for large expansion programs. Management realized that to accomplish this task, repair time and

mill delays had to be reduced to a minimum; hence, all existing equipment had to be operated at top efficiency. Management also realized that replacement parts and bearing metals needed for maintenance would be scarce. The steel companies met this tremendous challenge, and improved lubrication methods and improved practices assisted greatly in the expansion of steel production.

The author will show how the lubrication organization was set up in the typical rolling mill division, and at the same time, show the important part lubrication played in meeting the production goal that was set during World War II.

The heavy rolling mill division which is being used as an example, consisted, for the most part, of mills built during the early twentieth century. The lubrication practices in pre-World War II days, as has been stated, were crude. Black oil, cylinder oil, engine oil, gear shields, plunger greases, cup greases, and block greases constituted the type of lubricants used.

Gear shields were poured over open gearing with approximately 15 per cent efficiency. Oil was poured into bearings with comparable results. Mill oilers did not manually cover all locations requiring lubrication. Certain pieces of equipment had to be shut down to be lubricated safely, hence, a loss in production time.

Maintenance men spent most of the repair turns changing brasses while other important preventive maintenance work was neglected. Roll changes were frequent and costly. As a result, labor costs, power costs, high maintenance costs, and loss of production time were very high.

Management, now dissatisfied with these results, started to organize lubrication methods and procedures to cut down this prohibitive cost and loss of production time. The lubrication organization, which was set up originally in the heavy rolling mill division, started with the appointment of a division lubrication engineer. This engineer was responsible to the division superintendent of maintenance for lubrication methods and procedures. The plant lubrication engineer, who works under the direction of the engineering department, acts as a consultant in the division lubrication set-up. To avoid any misunderstanding in the remainder of this paper, the division lubrication engineer will be referred to as the lubrication engineer, whereas the plant lubrication engineer will be referred to as such.

The lubrication engineer first made a survey of the division and contacted various maintenance foremen with regard to the lubrication program that was to be set up. From this survey a program was established where both pressure lubricant dispensing systems could be installed on equipment which had high maintenance costs, and also on equipment which had to be shut down for lubrication purposes.

A test was conducted with the installation of a pressure lubrication system on the toughest application where maintenance costs were extremely high. Data were accumulated by the lubrication engineer from the results of the installation, and additional data were secured from records before the installation was made. A report was prepared which brought out savings in maintenance costs, increased production, power savings, and improved safety and good housekeeping. This report demonstrated the financial advantages of the modern lubrication methods.

One problem that confronted the lubrication engineer was the installation and maintenance of lubricating equipment in the division. The maintenance men in the mills could not assume the extra burden of maintaining this equipment. The problem was settled by originating a small but efficient lubrication gang, or group of men, trained to install and maintain lubrication equipment. This decision brought up many other problems; first, training these men in lubrication practices; second, setting up the number of men required in this gang for maximum efficiency; third, instructing these men in the installation and maintenance of lubrication systems; fourth, making instructors out of the men so that they might spread this knowledge to the mill oilers; and fifth, obtaining a leader with the knowledge of lubrication systems who would work with the lubrication engineer to insure the success of each installation.

A small shop and storage room was developed. This shop is centrally located and contains a pipe machine, drill press, table grinder, and other small equipment. A floor plan is shown in Figure 1. The shop is used for repair and testing of lubrication equipment, as well as for fabrication work for new installations.

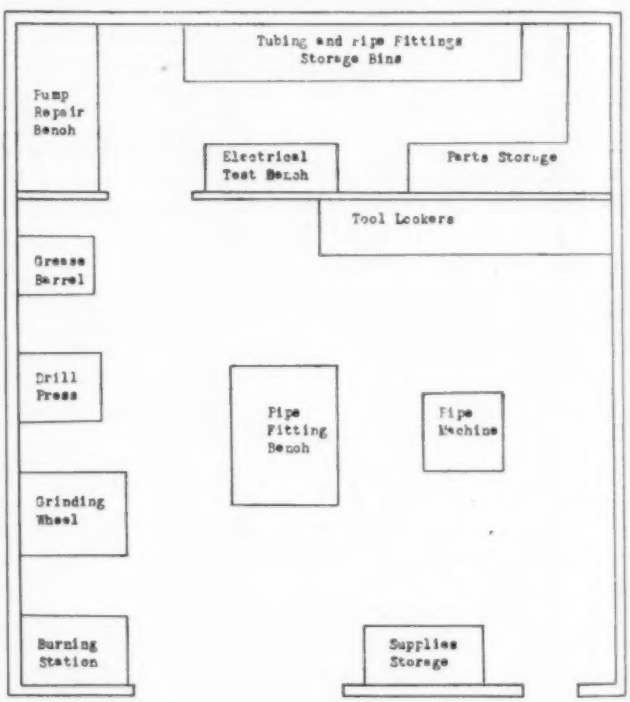

Figure 1 — Floor plan of lubrication shop.

A gangleader was secured who had previous experience with lubrication installation work and general pipefitting experience. Most of the men were actually trained on the job.

The division lubrication organization chart is shown in Figure 2. This chart shows the completed organization which was gradually built up to satisfy the division needs.

The organization as established proved to have the following advantages: first, installation work was accomplished at low cost; second, good maintenance of lubrication equipment was guaranteed; third, good

salvage of lubrication equipment was assured; fourth, men and materials were available for jobs without delay; and fifth, mill oilers were properly instructed how to operate and to report inoperative lubrication equipment.

With the lubrication gang established and the shop set up, machinery listed in the survey was equipped with lubrication systems as fast as material could be secured. The lubrication engineer ordered the material for the job. Any revisions that had to be made to drawings of bearings and caps for pressure lubrication systems were made by the lubrication engineer. The actual installation was accomplished by the lubrication group under the supervision of the division lubrication engineer.

After each installation on such equipment as roll stands, pinions, and other large pieces of equipment, the lubrication engineer wrote a detailed report on savings realized by these installations. Load charts of driving motors were taken before and after installations — power consumption was cut in some cases by one-third of its original amount. Bearing changes were reduced tremendously with the resultant savings in bearing metals and reduced cost. Equipment that could not be safely lubricated manually, while running, was not lubricated automatically while the equipment was operating. This resulted in more time available for production. These reports offered substantial proof that improved lubrication methods were beneficial and essential to increase production and better maintenance.

In the meantime, the division lubrication engineer worked along with the plant lubrication engineer in obtaining better grade lubricants throughout the division. At first the installation of lubrication equipment, securing of better grade lubricants, the training of the lubrication personnel, and revisions of bearings for new installations took up most of the lubrication engineer's time.

After a certain period of time elapsed, the lubrication gang became trained to the point where the top men could lay out, install, and maintain lubrication systems. An educational program familiarized these employees with the fundamentals of lubrication and also the grades of lubricants used. These men in turn convinced mill oilers that the improved lubrication methods were to their advantage. They were also instrumental in selling this lubrication program to the operating personnel. Their quick repair of lubrication equipment, and the fact that on repair turns these systems were checked quite closely, were factors that contributed to the success of the program.

The ground work being finished, the lubrication engineer now had time to spend on lubrication charts and to work on improving lubrication methods. Lubrication charts were developed for each mill, showing the equipment, the type of lubricant to use, the method and the time interval of application. A copy of these charts was given to the general maintenance foreman of each mill for use in the requisitioning of lubricants, and to train the oiler to use the right lubricant in the right place, in the right amount, at the right time.

Open gearing was still a problem. A study was made of methods to lubricate open gearing. With the aid of representatives of lubrication device manufacturers and lubricant manufacturers, the problem was partially

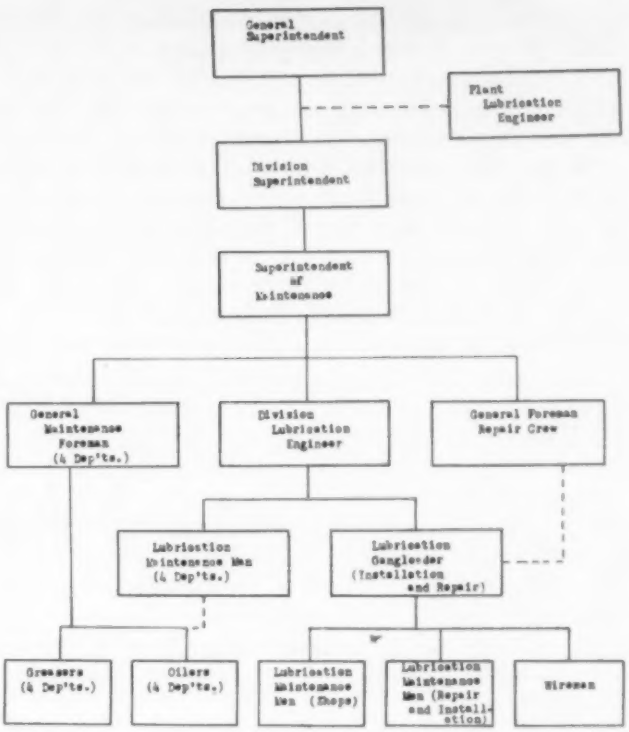

Figure 2 — Typical lubrication organization chart.

solved by the use of spraying a gear grease on the gears by means of an air-operated spray gun. As time progressed, the grease spray method has been improved. Further development is still in progress.

When the lubrication engineer of a steel plant has a problem and he works together with the design engineers, as well as with representatives of both lubricant manufacturers and lubricant dispensing manufacturers, the problem will usually be solved and very often a new lubrication method will be developed.

Many inefficient methods of lubrication were eliminated and good, positive lubrication methods replaced them.

The lubrication engineer of the division was also called in for consultation and advice on the lubrication feature of appropriation work concerning his division. This gave the lubrication engineer a chance to keep his practice and methods uniform at all times.

The organization under discussion for the typical division of the steel plant is not enough. The lubrication organization must function properly to be of value. Every person on the lubrication organizational chart has certain responsibilities to discharge.

The division superintendent, as head of the division, and his assistant, must give their full cooperation and support to this lubrication program to make it a success. A few moments of their time spent in an effort to promote such an organization will repay their efforts with better maintenance, greater productivity, lower costs, and good housekeeping.

The division lubrication engineer should be an adviser on any phase of lubrication to anyone in the division. He is directly responsible to the division superintendent of maintenance. The functions of the lubrication engineer should be as follows: first, to supervise the installation and maintenance of all lubricating equipment in

the division; second, to acquire good lubricants for every application and to be sure these lubricants are kept within specifications; third, to conduct all field testing of lubricants and to keep his superiors advised through the medium of test reports; fourth, to develop the value of all suggestions offered by representatives of a supplier of lubricant, or lubricant dispensing equipment; fifth, to set up a good training program for the instruction of mill oilers; sixth, to advise on any lubrication questions; seventh, maintain adequate supply of spares; and eighth, to keep in touch with any new lubrication methods or practices that are constantly being developed.

The division lubrication engineer should periodically go through the mills to check the various methods that have been put into effect, and to look for chances of improvement. Valuable information may be obtained by the lubrication engineer by talking to the operating men in the mills. He will benefit by the many years of experience of these men, and in turn, can sell the lubrication program to them. He should also check with mill superintendents and general maintenance foremen occasionally, offering suggestions or pointing out new lubrication developments that may be beneficial to them.

The general maintenance foreman in each mill is responsible for the proper operation of lubrication equipment in his mill. He is also responsible for requisitioning the lubricants that are needed in his mill.

The general foreman of the repair crew assists the lubrication engineer in the direction of the lubrication gang and shop. It is his responsibility to see that the lubrication gang is used to each mill's advantage.

The function of the lubrication gang is to install and repair lubrication equipment in all the mills of the division.

This type of lubrication organization insures economical and constantly improving lubrication practices, provides good maintenance of lubrication equipment, and promotes training opportunities.

In closing, the author would like to emphasize that such a lubrication organization as outlined above, functioning properly with up-to-date lubrication methods, can result in tremendous savings and better working conditions. We have better lubricants, fine lubricant dispensing equipment, and better lubrication methods today. Let us strive to constantly improve our methods and practices in the lubrication field.

DISCUSSION

PRESENTED BY

GEORGE FINDLAY, Lubrication Engineer, Republic Steel Corp., Buffalo, N. Y.

ROBERT R. TAYLOR, Division Engineer, Maintenance and Lubrication, Gary Steel Works, United States Steel Corp., Gary, Ind.

J. GLEBER, Lubrication Engineer, Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.

JOHN BOAL, Lubrication Engineer, Maintenance Committee, Homestead Works, United States Steel Corp., Munhall, Pa.

WILLIAM RIGOT, Maintenance Engineer-Lubrication, Fairless Works, United States Steel Corp., Morrisville, Pa.

A. E. CICHELLI, Lubrication Engineer, Bethlehem Steel Co., Bethlehem, Pa.

George Findlay: A lubrication organization as described by Mr. Taylor may function equally well in a smaller plant. However, the operations and scheduling of that smaller organization may have to be modified to suit local conditions.

In the smaller group, the leader in addition to the duties outlined by Mr. Taylor would be expected to inspect all lubrication equipment throughout the plant on a regular schedule, and furnish a report of his findings to the lubrication engineer, department superintendent, and department maintenance foreman.

The lubrication repairmen, because of their special training and also because of the special tools available to them, may be used successfully on other jobs requiring a large amount of work with copper tubing and fittings. Repair and maintenance of hydraulic brakes on overhead cranes and maintenance of autopour systems on pit cranes, etc., fits very well into the schedule of a lubrication department. In fact, in some small plants the inclusion of this type of work may be necessary to justify the initial cost of a lubrication department to management. However, care must be exercised to insure that lubrication and the repair of lubrication equipment is not neglected while performing this other work.

The lubrication engineer and the lubrication department of any steel plant, large or small, should accept some responsibility for locating and eliminating any leakage of lubricants and any seepage of used lubricants into the sewer system. Lubricants thus lost contribute largely to stream pollution. The prevention of stream pollution is becoming more important each year. In conclusion, I would like to ask Mr. Taylor if he will explain how the job of lubrication repairman is made sufficiently attractive to hold the highly trained men necessary for this type of work.

Robert R. Taylor: When this program was started, the men were actually trained on the job. As these men gradually became skilled in their work, they were put on a higher rate. The rates of pay for lubrication men were equivalent to other maintenance jobs such as millwrights, handymen and helpers.

This type of work is quite different from the regular maintenance work. The men do installation work along with repair work. The type of work consists of pipefitting, layout, machine assembly, tubing work, pump repair and some electrical maintenance. There is a great variety of work which keeps the average man interested. In other words, a man could be pipefitting one day, installing tubing the next day and repairing pumps the next day. There is enough variety of work to keep the man's interest high and there are always new developments under way to stimulate and add to the lubrication program.

J. **Gleber:** I heartily agree with the purposes of the paper since there is a definite need for well-organized, properly functioning lubrication programs in the steel industry. Most of the older type of equipment referred to by the author was before my time, but before coming out here I discussed it with Mr. Hand, and he says the figure of 20 per cent lubricant reaching the bearing is high. He says over 90 per cent only reached the floor.

In my personal experience, the biggest job in making any scientific lubrication program work is the education of the mill oiler to the process of lubrication and lubrication dispensing equipment, but the job does not stop there. Mill supervision must be lubrication conscious and the lubrication engineer must have the confidence of the mill superintendent and the cooperation of the mill oiler.

It is standard practice in our plant to issue with each new piece of equipment a proper lubrication chart and schedule and this has been the largest single contribution to the better plant lubrication.

The author's point of good designs for lubrication is one well taken. It is well known that a line can be changed easier on the drawing board and with a pencil than it can be changed in the field with a pipe wrench. The lubrication engineer should work closely with the engineering department whenever new mill equipment is being considered so that proper lubrication can be engineered along with the job.

Another good point Mr. Taylor brought out is the importance of the lubrication engineer staying close to his mills and constantly looking for improvement and discussing development with maintenance and operating personnel. These men are looking for results either in reduced maintenance or increased production; quite often, the lubrication engineer can help them both.

I have three questions I would like to ask Mr. Taylor. First, are each of the divisions of the plant staffed with a lubrication engineer, repairmen and such facilities?

Two, how were the division lubrication engineers secured, were they experienced, practical men, or college trained engineers?

And, third, is there any formal training program now given to mill oilers and greasers?

Robert R. Taylor: Each division of the plant is staffed with a lubrication engineer. However, the other divisions have not such a complete organization. The other divisions do have two or three repairmen and a smaller storage area.

Most of the division lubrication engineers were college trained men that were working in the division maintenance organization. The lubrication experience of these men was picked up from actual experience. It is my opinion that lubrication knowledge cannot be obtained in its entirety from a text book. Experience and the willingness to get out in the plant and get results is the best teacher.

The training of the oiler and greasers is actually accomplished by personal contact. The lubrication gang is in contact with the oiler constantly and they show the oiler how the equipment operates. They also answer any question that the oiler may have. The lubrication engineer should get out in the plant and contact the oilers and check the equipment also. Some of the men who are oilers cannot read, and some others are not too well educated, so personal contacts and actual demonstration are a necessity. The lubrication gang does more to educate the oiler than anyone else in the organization.

John F. Boal: The author is to be complimented for presenting a clear picture of the relation between a good lubrication organization and successful lubrication of equipment in a large steel plant. In creating this well functioning organization, it is evident that the author's plant is aware of the importance of lubrication in their plant maintenance program. There are still many places in today's steel plants where application of improved lubrication methods will extend equipment life and reduce maintenance costs.

There are definite advantages in having the application and maintenance of improved lubricating devices performed by a group in the plant which can devote full time to this work. Such a group can be given the training necessary to carry on their work in the proper manner. Without interruption by other duties, this group can proceed with efficiency and the desired results will be obtained in the shortest possible time. Giving the same group the responsibility for maintenance of the lubrication systems and for the instruction of lubrication personnel insures the proper functioning of the equipment installed and makes certain that the expected benefits will be realized. This is in contrast to the situation which often develops when an improved lubrication system has been installed without provision for adequate maintenance. Usually such a system fails to accomplish the desired results, and it is likely to be declared impractical and removed in favor of the previous hand methods.

In addition to improving methods of application, worthwhile savings may also be effected through use of improved lubricants. Greases have been receiving considerable attention both by suppliers and users and progress is continually being made in developing greases with more desirable performance characteristics. For example, greases are now available which have improved retention ability in bearings. When applied through automatic centralized systems this means that frequency of grease application may be reduced and savings realized through lower grease consumption. A lubrication organization such as described is in a good position to try new lubricants and arrive at an accurate evaluation of their performances in the plant equipment.

William Rigot: We at Fairless are at present involved with drawing up departmental organization charts, and these to a great degree will be similar, as concerns the lubrication organization, to those outlined by Mr. Taylor.

In this new plant we have the very latest in centralized grease systems, and other automatic lubricating devices. But these, as Mr. Taylor mentioned, are automatic only so long as they are properly installed and maintained. Here we differ from the older plants. We do not have an experienced pipefitter's gang to draw upon for men to install and maintain these systems. With so much automatic-type lubricating equipment, and faced with a personnel problem because of lack of experienced mill people, we will require extensive training programs to acquaint our people with the installation and maintenance of such systems.

Mr. Taylor also brought out a point, which I feel can be well taken. He mentioned the lubrication engi-

neer was called in for consultation, and advice on the lubrication features of appropriations work. This, we have found, will pay dividends.

A. E. Cichelli: Mr. Taylor made a remark in which he said you cannot learn lubrication from a book. I must take issue with this statement, since I believe the AISE, the ASLE and the ASME are trying hard to show that it can be done. Frankly, I think some progress has been made in that direction.

In the paper, a statement was made to the effect a lubrication engineer makes inspections as he goes around the plant. Does this mean he personally makes that inspection, or does each group make its own inspection, or is it made by the department millwrights? Who, in the final analysis, does the lubrication engineer depend upon to bring to his attention conditions encountered in such surveys? Would the author care to elaborate on this?

When such information is conveyed to the lubrication engineer, is it before or after the job has been taken care of? As you can see, this is a very important matter as far as the lubrication engineer is concerned. Information such as is found in plant inspections must reach him in ample time to be of any value. Too often field repairs are made before the experience and knowledge of the lubrication engineer can be applied.

Are regular inspections of oil and grease systems included in these surveys?

A question comes to mind concerning consultation by other departments with the lubrication engineer. To what extent is he called in for advice on technical problems? Is he called in before an item of equipment is to be purchased, or is he called in after it is purchased, and ready to be fabricated or installed?

From bitter experience, lubricating engineers have become a skeptical group of individuals. They know that unless someone specifically interested in lubrication is consulted, lubrication is likely to be given secondary consideration. Many troubles could be avoided, at least minimized, with very little effort expended in preliminary negotiations. It is therefore our point of view that lubrication engineers should be consulted for opinions on design of bearings, on the type of gears, even as to their metallurgy, as well as their customary recommendations on lubricants and lubricant application methods.

May we have the author's comments?

Robert R. Taylor: The theories of lubrication can be obtained from books on the subject. However, the actual lubrication knowledge that is required for a good operating lubrication know-how is obtained from actual experience. For example, the actual maintenance of pressure lubricant dispensing equipment is quite complicated. There are many things that can happen to this equipment which makes it inoperative. By actual experience one can tell in a matter of seconds what is wrong by certain symptoms. The trouble can be remedied quickly with the result that there is little loss of production and few failures of bearings.

The lubrication engineer should inspect lubrication equipment in his division. He should see that the equipment is being used properly and that the right lubricants are in use. The lubrication engineer should also depend on his gangleader to bring any conditions that he encounters to him also. The lubrication engineer should be able to arrange his time so that a monthly trip could be made through his division for such purposes. Regular inspection of oil and grease systems should be included in the survey.

The lubrication engineer is called in before the equipment is purchased. The engineering department should consult the division lubrication engineer while a new piece of equipment is still in the blue print form. Lubrication engineers must have an opportunity to submit their ideas in design of equipment for lubrication purposes to do a successful lubrication job.

Plan to Attend

1953 ANNUAL AISE CONVENTION

HOTEL WILLIAM PENN

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SEPTEMBER 28, 29, 30 AND OCTOBER 1

By H. H. ROTH
Engineer, Motor-Generator Section
Allis-Chalmers Manufacturing Co.
Milwaukee, Wis.

Paralleling Synchronous Frequency Changers

. . . . helpful hints on the technique of synchronizing synchronous frequency changer sets which are to be operated in parallel . . . .

▲ IN many countries electric power is generated at more than one frequency. Frequencies of 60, 25, 50, 30, and 40 cycles were used in the early development of power systems in the United States. Although 60 cycles is now generally used, there are still some localities and industries where power is generated and used at two frequencies. The steel industry in particular has a large amount of 25-cycle generating equipment installed, although its more recent installations are usually 60 cycle.

Where two systems of different frequencies furnish power to a common load, or where it is desirable to interconnect systems of different frequencies, some method of frequency conversion must be used. Synchronous frequency changer sets are frequently used for this purpose.

A synchronous frequency changer set consists of a synchronous motor coupled to a synchronous generator. Each unit operates in an entirely normal and relatively simple manner. However, when two or more synchronous frequency changer sets are to be operated in parallel, certain problems arise. Frequently these are not appreciated until parallel operation is attempted.

If a synchronous frequency changer set is in operation, and it is desired to parallel another set with it, an immediate problem may be encountered. The motor of the incoming set is started in the usual manner and field current is applied to pull it into synchronism. Field current is then applied to the incoming generator, but it may not be possible to synchronize the two generators due to a phase displacement between them.

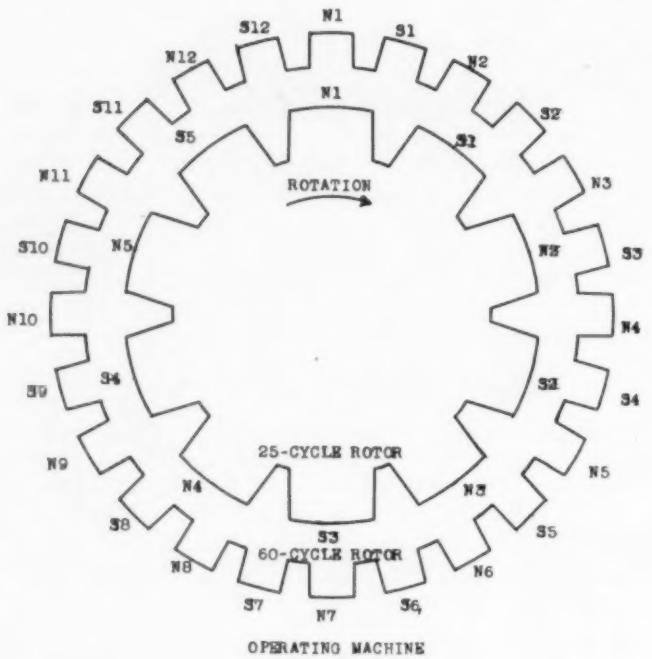
POLE DISPLACEMENT CAUSES PROBLEMS

This condition may be more easily understood by reference to Figure 1, which shows the relative pole positions of both machines of two 60/25-cycle, 300-rpm frequency changer sets. Assuming that the 60-cycle machines are the motors, if field current is applied so that pole N4 of the incoming machine assumes the same physical angular relation as pole N1 of the operating 60-cycle machine, it will not be possible to parallel the two 25-cycle generators, since they will be 90 electrical degrees out of phase.

Since the rotors of both the 25-cycle and 60-cycle machines of each set are keyed to a common shaft, their relative positions are fixed. Hence, in order to bring the rotors of the two sets into proper position for synchronizing, it is necessary to make the rotors of the incoming set slip backward a number of poles.

A study of Figure 1 will show that either pole N1 or N7 of the incoming 60-cycle motor must have the same physical angular relation with pole N1 of the operating 60-cycle motor in order that the poles of the two 25-cycle generators are in proper position to permit synchronizing. If poles N1 of both 60-cycle motors happen to have the same angular position, the 25-cycle generators can be synchronized at once. If poles N7 and N1 of the respective incoming and operating 60-cycle motors have the same angular position, then poles N1 and S3 of the 25-cycle generators will also have the same angular position. In this case, if the excitation polarity of the incoming generator is reversed, S3 will become a positive pole and the generators may be paralleled.

Figure 1 — Relative pole positions of two 60/25-cycle, 300 rpm, frequency changer sets are shown in this sketch.



Since the incoming 60-cycle motor may pull into step in 22 other angular positions with respect to the operating motor, it may be seen that there is only one chance in eleven of having the correct angular positions for synchronizing both ends of two sets on the first attempt. The incoming machine may be brought to the correct angular position by reversing the polarity of its excitation the proper number of times, since the motor will slip a pole each time the excitation is reversed. Field reversing switches on the control panels of both sets are used for this purpose.

When two or more synchronous frequency changer sets are to be operated in parallel, it is customary to provide all but one of the sets with a frame shifting device. This consists of a hydraulic or motor-operated mechanism by which the stator of the higher frequency machine of a set can be rotated to a limited extent. This permits adjusting the division of load between sets during operation by physically moving the stator ahead or back of its normal position. The paralleling of two sets is also more easily accomplished with this device, since the amount and power factor of the load on the operating machine will cause a shift between the magnetic axes of the two generators. By proper rotation of the stator of the incoming 60-cycle motor, the magnetic axes of the two generators may be brought together even if the operating generator is loaded.

PHASE SHIFTING DEVICE CORRECTS DISPLACEMENT

The phase displacement or relative angular positions of the two generators may be checked by use of a synchroscope supplemented by a voltmeter. The use of a voltmeter in conjunction with a synchroscope will permit accurate angular positioning and minimize electrical disturbances when the generators are paralleled. Unlike turbine driven or engine driven generators, the generators of synchronous frequency changer sets cannot assume their proper share of load if they are paralleled with an angular displacement between them. They are prevented from doing this by the synchronous driving motors, which are already in synchronism and which are rigidly coupled to the generator shafts. Such a condition will only cause the displacement angle to be divided between the two motors and the two generators, with a resulting circulating load between the sets. This can be corrected only by adjustment of the angular displacement by means of the frame shifting device.

The frame shifting device also serves another purpose. It may be seen from Figure 1 that there are

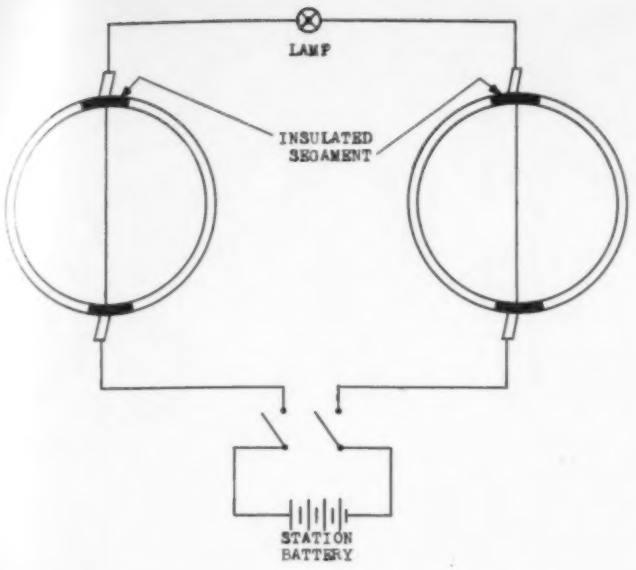


Figure 2 — Indicating system for determining correct angular position for synchronizing two frequency changer sets.

several relative angular positions that nearly satisfy the conditions for paralleling both ends of two sets. These occur where there are only a few mechanical degrees of displacement. Such a case exists where poles N4 and S6 of the two motors have the same angular position. By utilizing the frame shifting device on one machine and rotating its stator in the proper direction, the same effect can be achieved as if the rotor of that machine were shifted the few mechanical degrees necessary to correct for its displacement from proper paralleling position. This in effect permits proper paralleling of the two sets in some additional angular relationships so that a fewer number of poles may have to be slipped when paralleling.

When frame shift is provided, it is located on the frame of the higher frequency machine of the set, since this machine has the greater number of poles, and fewer mechanical degrees of shift will be required to accomplish the desired shift in electrical degrees. For 300-rpm sets the shifting device normally provides a 16-degree shift. For 500 or 514-rpm sets, a shift of 27 degrees is provided, and for 720 or 750-rpm sets a 38-degree shift is normally provided. The speed of a frequency changer set is, of course, determined by using the highest common speed of the two frequencies, such as 300 rpm for a 60/25-cycle set or 750 rpm for a 50/25-cycle set.

It is possible to arrange an indicating circuit to show when the incoming set is in the proper position for synchronizing. This can be accomplished by providing a collector ring on the shaft of each set, as shown in Figure 2. For a 60 to 25-cycle conversion the slip rings would have two insulated segments located 90 mechanical degrees apart. The two insulated segments of each ring would be electrically connected, and an electric light bulb would be inserted in the circuit as shown.

When the incoming set reaches the proper angular position, the light will flash, as its circuit is alternately completed and broken. The conducting slip ring segments must be selected for proper length to suit the number of poles of the two units. If the operating set is loaded, the stator shifting device of the incoming set should first be operated to shift its stator backward with respect to the direction of rotation to a point dependent upon the amount of load the operating set is carrying. This is necessary because the load on the operating set has caused the rotor of its motor to lag behind its no-load position, and the incoming set is, of course, operating at no load. Operating experience will indicate the approximate setting of the incoming machine stator, corresponding with the load on the operating set. Various modifications of this arrangement can be made to suit the requirements of the units involved.

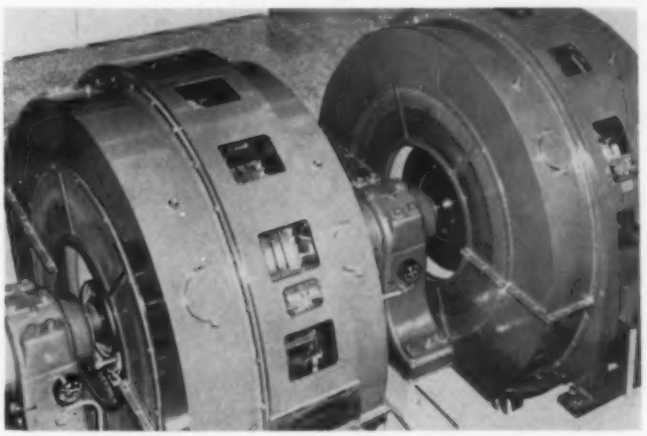
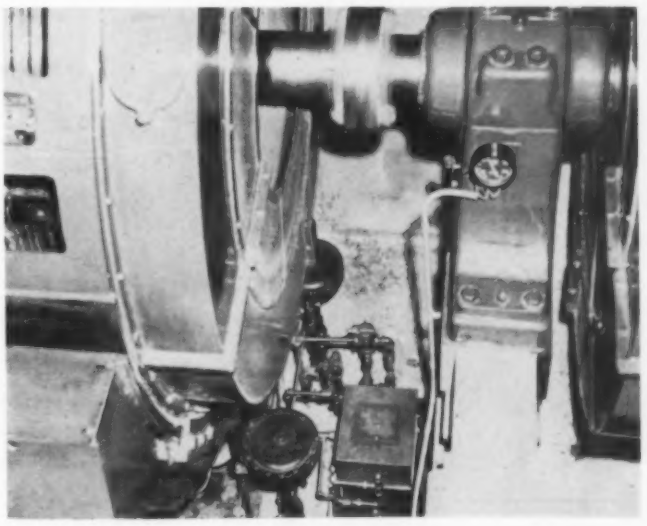
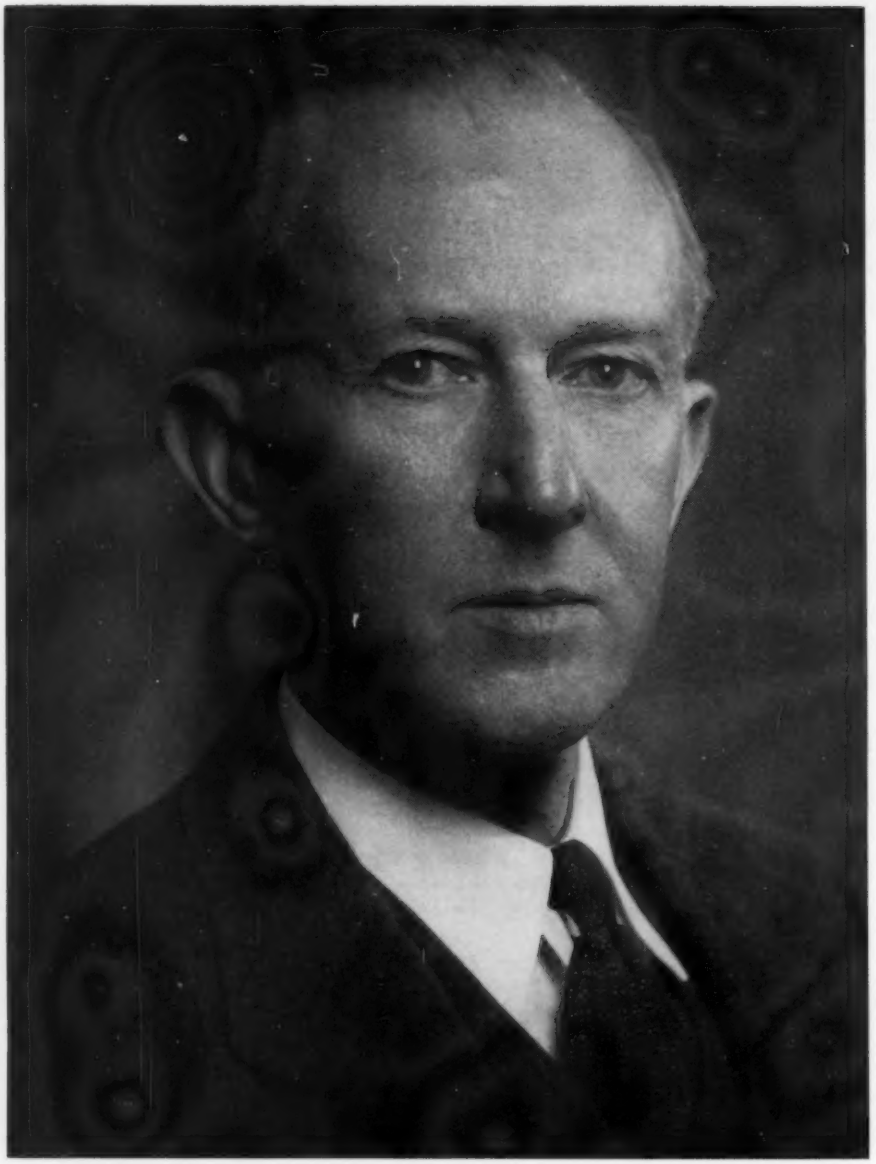


Figure 3 — The use of 25-cycle power in the steel industry has required the application of much frequency changing equipment.

The various possible pole combinations of frequency changer sets can be studied by making pole layouts in duplicate for the particular machines under consideration, similar to the diagrams of Figure 1. The diagram for one set should be made on transparent paper and placed over the other diagram, with a pin holding the two together at the axis. Rotation of the transparent diagram will permit observation of the various angular displacements which will be encountered in the paralleling of the sets.

Figure 4 — Close-up of equipment shown in Figure 3.





John L. Young

PRESIDENT, 1953

ASSOCIATION OF IRON AND STEEL ENGINEERS

JOHN L. YOUNG, a native of Evansville, Ind., graduated from University of Indiana, in 1921. Mr. Young began his career with Timken Roller Bearing Co. in Canton, Ohio, where he held various positions in the alloy tube and steel departments; he later transferred to the metallurgical department. In 1930, Mr. Young went to Pittsburgh for Timken as a development engineer and later was district manager. In 1934, he returned to Canton and became assistant general manager of Timken's industrial division. Mr. Young joined United Engineering and Foundry Co., Pittsburgh, Pa., in 1936. In 1941, he was loaned as project manager to design and construct the Defense Plant Corp.'s aluminum rolling mills at Trentwood, Wash. He was next vice president in charge of industrial research and development for United Engineering and Foundry Co. He then moved to National Tube Co. in 1945 as vice president in charge of engineering. On January 1, 1951, he became vice president–chief engineer of the United States Steel Co. in Pittsburgh. In January 1952, he was made vice president–engineering which position he now holds.

The President's Message

For the past twelve years American industry has been booming along in an unprecedented sellers' market. Statisticians and economists now tell us that during the first half of 1953 our overall production will continue to boom, but during the third and fourth quarters there will be a slackening of pace. But before we allow harbingers of gloom to get us down, before we think ourselves into a recession, let's take a good look at the situation.

Our steel industry has been running at a rate of well over 100 per cent of capacity, which is not a healthy condition because costs go up disproportionately when production exceeds a balanced rate. Such operations wear out equipment faster and entail the use of marginal, high-cost facilities, thus reducing the profit margin. Greatest efficiency and lowest costs can be obtained when plants are operated at rated capacity or slightly below that level. So let's think right and plan right. Optimism is stimulating, and we of the Association of Iron and Steel Engineers can aid materially in the overall thinking of our industry.

The return of a normal and healthy state of competitive selling that accompanies a buyer's market will put emphasis on operating economies. It will be essential that every department and every step in the production process be scrutinized closely to eliminate waste and improve efficiency.

Effective solutions to the problems that will arise will require all the knowledge and ingenuity of every engineer and supervisor in the industry. The Association of Iron and Steel Engineers will continue to be of as much help as is possible in meeting these problems, and with the active cooperation of its members, it can increase its service to the iron and steel industry.

JOHN L. YOUNG

President, AISE

E. L. ANDERSON
First Vice President

JOHN H. VOHR
Second Vice President

W. H. COLLISON
Treasurer

NEWLY ELECTED OFFICERS AND DIRECTORS

E. L. ANDERSON has been associated with the iron and steel industry for over 30 years, having started in the electrical department of the Bethlehem Steel Co. at Sparrows Point, Md., in 1917. He was transferred to the Johnstown plant of Bethlehem in 1937, and was appointed superintendent of the electrical department of that plant in 1940. He has served in that capacity until the present time.

JOHN H. VOHR was graduated from Cornell University in mechanical and electrical engineering in 1916 and became associated with the New York State Railways as an electrical engineer. After serving in World War I, he joined the American Sheet and Tin Plate Co. at Farrell, Pa., and later was transferred as assistant superintendent of strip mills to the company's plant at Gary. After leaving the company in 1931, he was engaged with the installation and operation of the wide strip mills of the Inland Steel Co. and Youngstown Sheet and Tube Co. In 1936 he joined the Granite City Steel Co., Granite City, Ill. as superintendent of the hot and cold strip mills and was promoted in 1937 to general superintendent of plants. In 1942 he went with the Carnegie-Illinois Steel Corp., being stationed at the general offices in Pittsburgh until his appointment in 1943 as assistant general superintendent of South Works of Chicago, Ill. In 1949, he was promoted to the general superintendency of Gary, Ind. Steel Works.

W. H. COLLISON was graduated from the University of Cincinnati in 1926 with a degree of chemical engineer. This was a cooperative course during which he worked in the coke plant of Pittsburgh Crucible Steel Co., beginning in 1924, continuing after graduation until 1927. He then went to the Central Alloy Steel Corp., Massillon, Ohio, as heater in the coke plant, and was made turn foreman shortly thereafter. In 1935, Mr. Collison went with the Pure Oil Co., Marcus Hook, Pa., as a chemist. Following this he came to Detroit as boss heater for the new coke plant of Great Lakes Steel Corp., being subsequently promoted to assistant superintendent and later to superintendent of the coke plant. In 1951 he was made assistant general superintendent, blast furnace division.

JAMES D. O'ROARK was born in Broadway, Va., and received grade and high school education in Covington, Ohio. He graduated from Ohio State University in 1926 with a degree in electrical engineering. After graduation he was employed in student engineer training course and test floor from 1926–1930 at Westinghouse Electric Corp.'s East Pittsburgh works. He has been employed by Weirton Steel Co. from 1931 to present date as electrical field engineer, electrical foreman of strip steel and sheet mill dept., assistant electrical superintendent, electrical superintendent, and assistant to manager of service and maintenance, which last position he now holds.

LEONARD LARSON was employed as draftsman at Jones & Laughlin Steel Corp. and Carnegie Steel Co. in Pittsburgh, Pa. from 1913 to 1917, while attending night school at Carnegie Tech. He moved to Massillon in 1917 as draftsman for Central Steel Co., was appointed chief draftsman in 1918, and assistant chief engineer about 1923. He was appointed assistant chief engineer for Central Alloy Steel Corp., in 1926 in merger between Central Steel Co. and United Alloy Steel Corp., and was appointed chief engineer in 1929. He served in this capacity for Central Alloy Steel Corp., and Republic Steel Corp., after merger in 1930, until 1939, when he was transferred to Cleveland District as district chief engineer which position he now holds. During period from 1933 to 1936, he spent about one year on special open hearth work for the corporation, and about two years in the operating department as divisional superintendent at the Massillon Steel plant.

E. T. W. BAILEY was born at Hawkesbury, Ontario, Canada, and received early education at Lakefield and Peterborough, Ontario, Canada. He graduated from the University of Toronto with a degree of bachelor of applied science in 1926. In 1932 he received the professional degree of chemical engineer from the same institution. After graduation he joined the staff of the Aluminum Co. of Canada, Ltd., Arvida, Quebec, where he acted as assistant chief chemist. In 1928 he transferred to the engineering department of the Steel Co. of Canada, Ltd., in Hamilton, Ontario, and some years later became chief combustion engineer.

JAMES D. O'ROARK
Secretary

LEONARD LARSON
Director-at-Large

E. T. W. BAILEY
Director

WALTER W. BENTZ
Director

L. V. BLACK
Director

A. M. CAMERON
Director

ASSOCIATION OF IRON AND STEEL ENGINEERS 1953

WALTER W. BENTZ was born near Uniontown, Pa. in 1909, and attended public schools in Scottdale, Pa. He worked with the U. S. Pipe & Foundry Co. at Scottdale, Pa. from 1926 through 1932. He then secured a job with Carnegie Steel Co., McDonald plant, as motor inspector helper in 1933. He graduated from Bliss Electric School, Takoma Park, Md. with the class of 1935. He progressed at the McDonald plant as motor inspector, lineman, turn foreman, and general foreman electrical while attending night school classes until 1945. Promoted to assistant to superintendent of the department for the Youngstown district, Carnegie-Illinois Steel Co., he was later promoted to assistant superintendent electrical, superintendent of combined maintenance at the McDonald & Upper Union plant of Carnegie-Illinois. He is now employed as superintendent of maintenance shops and utilities at the McDonald plant of United States Steel Corp.

L. V. BLACK, was graduated from Penn State in 1915, with a BS in Electrical Engineering. Starting as a wireman on construction work at the Bethlehem plant of Bethlehem Steel Co. immediately after graduation, he has remained there until the present time. He served as a maintenance repairman; foreman; foreman of power and distribution, and in 1929 he became assistant superintendent of electrical department. In 1938 he was made superintendent of electrical department, and has served in that capacity until the present time.

A. M. CAMERON was born in Pictou County, Nova Scotia, and educated in the Trenton, Nova Scotia, schools and at Carnegie Institute of Technology. He served his apprenticeship as a roll turner at the Nova Scotia Steel & Coal Co. and then moved to Crucible Steel Co. of America, Pittsburgh, Pa. He later worked as roll shop foreman at the Philadelphia Roll & Machine Co., and as roll designer for the Jessop Steel Co., Washington, Pa. In 1929, Mr. Cameron was employed as roll designer at Atlas Steels, Ltd., Welland, Ontario, and has since held positions of production planning, assistant superintendent of rolling and forging. In April, 1951, he was appointed superintendent of rolling mills and S. P. Forge.

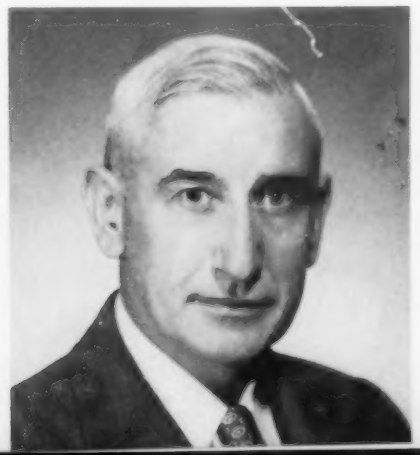
T. M. FAIRCHILD, was born in Portville, New York in 1912. He graduated from Pennsylvania State College, School of Mineral Industries with a BS Degree in Ceramics. In that same year he was employed by Bethlehem Steel Co.'s Johnstown plant, where he has remained until the present time. He began his career as a ceramic engineer, and since has served as general foreman, brickmasons; assistant superintendent, yard department. In 1949 he became assistant to general manager which position he now holds.

F. A. JOHANTGES received a B.S.E.E. degree from Purdue University in 1926; was in the General Electric Student Test Course for one year, and then was transferred to their Chicago district in the service department. In 1928, he was transferred to their St. Louis district on construction and service work until 1936. He went to the Wisconsin Steel works of the International Harvester Co. in 1936 as a test engineer, advanced to assistant electrical engineer in 1939 and to electrical engineer in 1950 which position he now holds.

EMIL KERN was graduated from the University of Stuttgart, Germany, in 1926, and began his career as a machinist and designer with Mesta Machine Co. in 1930. He became associated with Reynolds Metals Co. as chief mechanical engineer in 1945, and joined the Allegheny Ludlum Steel Corp., Pittsburgh, Pa. as chief engineer the following year. In May 1949, he was elected a vice president of the Allegheny Ludlum Steel Corp.

T. M. FAIRCHILD
Director

F. A. JOHANTGES
Director



EMIL KERN
Director

ROBERT A. KRAUS
Director

D. W. LLOYD
Director

C. G. MARSHALL
Director

ROBERT A. KRAUS, a native of Chicago, obtained bachelor and master degrees in mechanical engineering at the Illinois Institute of Technology. In 1939 he entered the steel industry joining the Republic Steel Corp., in Chicago as a junior mechanical engineer moving up later to an industrial engineer. In 1943 he was appointed lubrication engineer, and in this capacity assisted in the construction of the Republic Chicago Defense Plant. In 1947 he was named to the position of general mechanical foreman for the Chicago plant. He now serves as assistant maintenance superintendent.

D. W. LLOYD, began his career in 1930 with the General Electric Co. in Cleveland, Ohio where he was employed as a draftsman. He became associated with the steel industry at the McDonald Works of Carnegie-Illinois Steel Corp. in the roll designer's office in 1932. He joined Republic Steel Corp. where he served in the operating department until 1935, at which time he was employed by Youngstown Sheet and Tube Co. His initial job with Youngstown was that of practice engineer in the rolling division, and in 1937 he became general foreman of the blooming mill, intermediate bloomer and round mills. In 1940 he was promoted to superintendent, and in 1947 became general superintendent of Brier Hill Works which position he now holds.

C. G. MARSHALL was born and reared in Alabama. He received his BS in Electrical Engineering at the University of Alabama in 1940. After graduating, he was employed by the Tennessee Coal, Iron and Railroad Co. in the Coal Mining Division. Consecutively, he served as junior engineer, assistant electrical engineer, general maintenance foreman and electrical engineer. In 1949, he was made maintenance engineer, coal mines. He was promoted to superintendent of construction engineering — raw materials division which position he now holds. He is registered and entitled to practice professional engineering in the State of Alabama.

JOHN S. MORRIS started his steel career as a looper in the Bethlehem Steel Co.'s training course at Bethlehem, Pa. in June 1928. He went to their Sparrows Point plant as a third helper in the open hearth, in September 1928, and then progressed through the jobs of second and first helper, open hearth combustion engineer, combustion engineer, finishing division, and assistant fuel engineer, finishing division. In July 1941 he accepted a job with the Alan Wood Steel Co. as assistant to general manager. From January 1942 to 1949, he was special projects engineer at the Lukens Steel Co., and from 1949 to 1951 supervisor of centralized maintenance cost control. In June 1951 he was appointed supervisor of construction, Lukens Steel Co., which position he now holds.

FRANK E. ROBINSON was born in Lima, Ohio and a few years later moved to Birmingham, Alabama, where he attended public schools and technical high school. During the first world war he was employed by Tennessee Coal, Iron & Railroad Co. as a draftsman on the construction of the first units of Fairfield works. In 1920 he came to Cleveland with Otis Steel Co., as chief draftsman in the blast furnace division, and completed a night school course in mechanical engineering at John Huntington Polytechnic Institute. In 1925 he began working for American Steel & Wire Div., U. S. Steel Corp. as designer-checker, later being advanced to section head draftsman, assistant construction engineer, and in 1945 to a newly created position of division engineer of projects. At the present time he is assistant division engineer.

ROBERT SERGESON was born in Philadelphia, Pa., and graduated from University of Pennsylvania in 1922 with a BS in Chemical Engineering. He entered employ of the Central Steel Co., Massillon, Ohio, working in the metallurgical laboratory and subsequently in open hearth, soaking pits and bar mills. He remained with this company after its merger into Central Alloy Steel Co. and later into Republic Steel Corp., being in charge of the metallurgical laboratory for eight years. In 1938 Mr. Sergeson joined the Park works of the Crucible Steel Co. of America, Pittsburgh, Pa. as chief metallurgist, remaining till 1945, when he became chief metallurgical engineer of Rotary Electric Steel Co., Detroit, Mich.

JOHN S. MORRIS
Director

FRANK E. ROBINSON
Director

ROBERT SERGESON
Director

National Committees for 1953

ASSOCIATION OF IRON AND STEEL ENGINEERS

General Chairman, John L. Young

ADVISORY COMMITTEE

Past Presidents, AISE

1907-1908 JAMES FARRINGTON, *Assistant to Chief Plant Engineer*, Wheeling Steel Corp., Steubenville, Ohio.
1919 D. M. PETTY, *President*, Philadelphia, Bethlehem & New England Railroad Co., Bethlehem, Pa.
1921 E. S. JEFFERIES, Worcester, Mass.
1923 R. B. GERHARDT, *Consulting Engineer*, United Engineers and Constructors, Inc., Philadelphia, Pa.
1924 R. S. SHOEMAKER, *Cincinnati District Manager*, Brooks Oil Co., Middletown, Ohio.
1926 G. H. SCHAEFFER, *Consulting Engineer*, Reading, Pa.
1930 F. W. CRAMER, *Consulting Engineer*, Elliott Co., Pittsburgh, Pa.
1931 F. O. SCHNURE, *Electrical Superintendent*, Bethlehem Steel Co., Sparrows Point, Md.
1932 J. J. BOOTH, *Assistant to Chief Engineer, Construction Bureau*, United States Steel Corp., Pittsburgh, Pa.
1933 J. D. DONOVAN, Massillon, Ohio.
1935 W. H. BURR, Coatesville, Pa.
1937 H. G. R. BENNETT, Eustis, Fla.
1938 L. F. COFFIN, *Assistant General Manager*, Bethlehem Steel Co., Sparrows Point, Md.
1939 C. CLARKE WALES, *Chief Project Engineer*, National Tube Co., Lorain, Ohio.
1940 J. A. CLAUSS, Walled Lake, Mich.
1941 *Chairman:* W. A. PERRY, *Assistant General Superintendent, Service*, Inland Steel Co., East Chicago, Ind.
1943 F. E. FLYNN, *District Manager*, Republic Steel Corp., Warren, Ohio.
1944 CHARLES L. McGRANAHAN, *Technical Assistant to Works Manager*, c/o Sollac, Seremange, Moselle, France.
1945 J. L. MILLER, *Assistant Chief Combustion Engineer*, Republic Steel Corp., Cleveland, Ohio.
1946 FREEMAN H. DYKE, *Vice President*, U. S. Metals Refining Co., Carteret, N. J.
1947 L. R. MILBURN, *Consulting Electrical Engineer*, Whitmore Lake, Mich.
1948 A. J. FISHER, *General Manager*, Bethlehem Steel Co., Johnstown, Pa.
1949 C. H. WILLIAMS, *Assistant Executive Vice President Engineering and Raw Materials*, United States Steel Corp., Pittsburgh, Pa.
1950 A. S. GLOSSBRENNER, *Vice President of Operations*, Youngstown Sheet and Tube Co., Youngstown, Ohio.
1951 JOHN F. BLACK, *Manager, Continuous Casting Section*, Freyn Engineering Dept., Koppers Co., Inc., Chicago, Ill.
1952 I. N. TULL, *Electrical Superintendent*, Republic Steel Corp., Corrigan-McKinney Works, Cleveland, Ohio.

MEMBERSHIP COMMITTEE

Chairman: JOHN H. VOHR, *General Superintendent*, United States Steel Corp., Gary, Ind.
EMIL KERN, *Vice President Charge of Engineering*, Allegheny Ludlum Steel Corp., Brackenridge, Pa.
W. W. BENTZ, *Superintendent, Maintenance Shops*, United States Steel Corp., McDonald, Ohio.
GORDON PATRICK, *Planner, Maintenance Department*, Tennessee Coal & Iron Division, United States Steel Corp., Fairfield, Ala.
GEORGE W. NIELSEN, *Mills Master Mechanic*, Tennessee Coal & Iron Division, United States Steel Corp., Fairfield, Ala.
W. D. CHAPPELL, *Application Engineer*, Westinghouse Electric Corp., Buffalo, N. Y.
R. R. KOTTMEIER, *Technical Representative*, Canadian Liquid Air Co., Ltd., Hamilton, Ontario, Canada.
L. A. TERRY, *Superintendent Power and Electric Department*, National Tube Division, United States Steel Corp., Gary, Ind.
L. H. COLEMAN, *Market Development Engineer*, Leeds and Northrup Co., Chicago, Ill.
G. C. BRAINARD, JR., *Assistant Superintendent*, Cold Strip Mill, Youngstown Sheet and Tube Co., Youngstown, Ohio.
WM. C. McCONNELL, JR., *Sales Engineer*, Reliance Electric and Engineering Co., Cleveland, Ohio.
H. C. HOEFT, *Assistant Chief Electrical Engineer*, Great Lakes Steel Corp., Ecorse, Detroit, Mich.
T. A. SHANNON, *Field Engineer*, The Farval Corp., Cleveland, Ohio.
J. W. DEIMLER, *Sales Engineer*, Towle & Son Co., Philadelphia, Pa.
M. E. CARSON, *Chief Engineer*, Bethlehem Steel Co., Steelton, Pa.
D. E. WHITEHEAD, *Lubrication Engineer*, Crucible Steel Co. of America, Pittsburgh, Pa.
J. P. CRITCHLOW, *Chief Fuels and Lubricants Engineer*, Gulf Oil Corp., Pittsburgh, Pa.

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(Chairman, sub-committee, low voltage a-c control)
M. B. ANTRIM, *Superintendent Electrical Maintenance*, Lukens Steel Co., Coatesville, Pa.
(Chairman, sub-committee on mill motors)
A. H. ARBOGAST, *Combustion Engineer*, Combustion Division, Bethlehem Steel Co., Bethlehem, Pa.
(Chairman, sub-committee on development of data for steel plant air filters)
J. E. BODOH, *Chief Electrical Engineer*, United States Steel Corp., Gary, Ind.
(Chairman, sub-committee on wiring)
C. G. DIMITT, *Supervisor—Electrical Design Engineering*, United States Steel Corp., Chicago, Ill.
(Co-Chairman, sub-committee on wiring)
J. C. FOSTER, *Assistant Chief Engineer of Construction*, Construction and Engineering Department, Bethlehem Steel Co., Bethlehem, Pa.
(Chairman, sub-committee on blast furnace thermal distribution)
WADE F. HOFFMAN, *Superintendent Roll Department*, Jones and Laughlin Steel Corp., Aliquippa, Pa.
(Chairman, sub-committee on hot strip mill work roll breakage)

FRANK O. PHILLIPS, *Division Superintendent of Maintenance*, United States Steel Corp., Duquesne, Pa.
(Chairman, sub-committee on motor brushes)
C. E. PRITCHARD, *Superintendent of Mills*, Alan Wood Steel Co., Conshohocken, Pa.
(Chairman sub-committee on handbook of lubrication standards for the steel industry)

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W. J. TUNNY, *Superintendent Electrical Maintenance*, Youngstown Sheet & Tube Co. East Chicago, Ind.
A. F. KRITSCHER, *Development Engineer*, National Tube Division, United States Steel Corp., Pittsburgh, Pa.
PAUL E. THOMAS, *Assistant General Superintendent*, United States Steel Corp., Gary, Ind.
J. N. IMEL, *Superintendent, Continuous Strip and Sheet Department*, Jones and Laughlin Steel Corp., Pittsburgh, Pa.
F. E. ROBINSON, *Assistant Division Engineer*, American Steel and Wire Division, United States Steel Corp., Cleveland, Ohio.
WILLIAM M. SCHUCK, *Lubrication Engineer*, Armco Steel Corp., Middletown, Ohio.

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K. L. JOHANNSEN, *Division Superintendent Maintenance and Utilities*, United States Steel Corp., Morrisville, Pa.
L. V. BLACK, *Superintendent Electrical Dept.*, Bethlehem Steel Co., Bethlehem, Pa.
A. J. F. MacQUEEN, *Electrical Superintendent*, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, Canada.
R. T. WINTERRINGER, *Assistant Superintendent, Electrical Dept.*, Republic Steel Corp., Chicago, Ill.
F. H. WICKLINE, *Electrical Engineer*, National Tube Div., United States Steel Corp., Pittsburgh, Pa.
D. C. McCRADY, *Superintendent, Electrical Dept.*, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.
R. T. LUCAS, *Electrical Superintendent*, Weirton Steel Co., Weirton, W. Va.

COMBUSTION ENGINEERING DIVISION

Chairman: A. F. KRITSCHER, *Development Engineer*, National Tube Division, United States Steel Corp., Pittsburgh, Pa.
G. J. GOCKSTETTER, *Chief Combustion Engineer*, Republic Steel Corp., Chicago, Ill.
F. R. PULLEN, *Fuel Engineer*, Bethlehem Steel Co., Johnstown, Pa.
G. H. KRAPF, *Assistant Chairman, Power and Fuel Committee*, United States Steel Corp., Pittsburgh, Pa.
F. BRUCE BEVELHEIMER, *Power and Fuel Engineer*, Ford Motor Co., Dearborn, Mich.
EDWARD H. CAUGER, *Chief Combustion Engineer*, Wheeling Steel Corp., Steubenville, Ohio.
E. T. MORTSON, *Superintendent, Power and Fuel*, National Tube Div., United States Steel Corp., McKeesport, Pa.
R. A. LAMBERT, *Superintendent Steam Efficiency and Combustion Department*, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

OPERATING PRACTICE DIVISION

Chairman: PAUL E. THOMAS, *Assistant General Superintendent*, United States Steel Corp., Gary, Ind.
CARL G. HOGBERG, *Assistant Chairman, Blast Furnace Committee*, United States Steel Corp., Pittsburgh, Pa.
ROBERT SERGESON, *Chief Metallurgical Engineer*, Rotary Electric Steel Co., Detroit, Mich.
JAMES A. BELL, *Chief Engineer*, Bethlehem Steel Co., Bethlehem, Pa.
S. O. EVANS, *Chief of Engineering*, Babcock and Wilcox Tube Co., Tubular Products Division, Beaver Falls, Pa.
GEORGE GREENE, *Assistant General Manager*, Bethlehem Steel Co., Johnstown, Pa.
W. E. HART, *Superintendent, Electric Furnace Building*, Ford Motor Co., Dearborn, Mich.
ROBERT W. HOLMAN, *Assistant General Superintendent*, Gary Sheet and Tube Mill, United States Steel Corp., Gary, Ind.

ROLLING MILL DIVISION

Chairman: JAMES N. IMEL, *Superintendent, Continuous Strip and Sheet Dept.*, Jones and Laughlin Steel Corp., Pittsburgh, Pa.
ALEX MONTGOMERY, JR., *Assistant to Vice President — Rolling Mills*, United States Steel Corp., Pittsburgh, Pa.
GEORGE A. HENDERSON, *Superintendent of Mills*, Bethlehem Steel Co., Lackawanna, N. Y.
C. S. LAMBERT, *Superintendent Merchant Mills*, Youngstown Sheet and Tube Co., Youngstown, Ohio.
G. L. PIMLOTT, *Assistant Superintendent Bar Mills*, Republic Steel Corp., Cleveland, Ohio.
A. KRAUSE, *General Superintendent, Rolling Mills*, Ford Motor Co., Dearborn, Mich.
A. M. CAMERON, *Superintendent of Rolling Mills*, Atlas Steels, Ltd., Welland, Ontario, Canada.
LOUIS MOSES, *Mill Engineer*, Bethlehem Steel Co., Bethlehem, Pa.

MECHANICAL AND WELDING DIVISION

Chairman: F. E. ROBINSON, *Assistant Division Engineer*, American Steel and Wire Div., United States Steel Corp., Cleveland, Ohio.
E. C. HITE, *Maintenance Engineer*, Steel and Tube Division, Timken Roller Bearing Co., Canton, Ohio.
C. J. KLEIN, *Vice President Engineering*, Weirton Steel Co., Weirton, W. Va.
F. M. DARNER, *Chief Engineer, Manufacturing Division*, Republic Steel Corp., Cleveland, Ohio.
C. E. HOMER, *Superintendent Maintenance and Power*, Youngstown Sheet and Tube Co., East Chicago, Ind.
J. B. WHITLOCK, *General Maintenance Engineer*, Armco Steel Corp., Middletown, Ohio.
C. W. BRUCE, *Chief Engineer*, Republic Steel Corp., Chicago, Ill.
M. D. AYERS, *Chief Engineer*, Wheeling Steel Corp., Wheeling, W. Va.

LUBRICATION ENGINEERING DIVISION

Chairman: WILLIAM M. SCHUCK, *Lubrication Engineer*, Armco Steel Corp., Middletown, Ohio.
D. N. EVANS, *Assistant Superintendent Mechanical Department*, Inland Steel Co., East Chicago, Ind.
C. E. PRITCHARD, *Superintendent of Mills*, Alan Wood Steel Co., Conshohocken, Pa.
N. I. WHITELEY, *Lubrication Engineer*, American Steel and Wire Div., United States Steel Corp., Cleveland, Ohio.
DONALD E. WHITEHEAD, *Lubrication Engineer*, Crucible Steel Co. of America, Pittsburgh, Pa.
KARL A. ARNOLD, *Lubrication Engineer*, National Tube Div., United States Steel Corp., Ellwood City, Pa.
C. A. BAILEY, *Lubrication Engineer*, National Tube Div., United States Steel Corp., Pittsburgh, Pa.
A. E. CICHELLI, *Lubrication Engineer*, Construction and Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

EDUCATIONAL COMMITTEE

Chairman: ERIC ANDERSON, *Electrical Superintendent*, Bethlehem Steel Co., Johnstown, Pa.
W. H. COLLISON, *Assistant General Superintendent*, Blast Furnace Division, Great Lakes Steel Corp., Ecorse, Detroit, Mich.
LEONARD LARSON, *Chief Engineer*, Republic Steel Corp., Corrigan-McKinney Wks., Cleveland, Ohio.

Developments

IN THE IRON AND STEEL INDUSTRY

During 1952

By I. E. MADSEN

▲ 1952 for the steel industry was a year of contrasts, a year which included some of the most intense emphasis on production in the history of the industry, along with a long period of unparalleled idleness, a result of the steel strike and the seizure of the industry by the government. It was a year in which the industry made enormous strides in cutting into the backlog of steel requirements, a year, which at its end, saw the goal approaching where capacity and production would be substantially in line with demand.

With this balancing of capacity and demand, the steel industry will enter into a new era, an era of competition, an era in which the plant best set up for efficient and economical production will find its foresightedness rewarded, and an era in which the less efficient unit will find itself on the sidelines or producing at a loss. The coming year is therefore a year for putting into operation and practice the new equipment and new developments which have been introduced slowly because of pressure for production. It will be a period for the development of new techniques and new practices, for ingenuity, and for the skill of the operator.

Although the steel industry has made enormous strides in increasing productive capacity, it is estimated that this will be required to support a growing industrial economy. Economists estimate that our economy increases 3.3 per cent every year, taking out all effects of inflation. As an example of the increasing requirements for steel, one of the largest electrical manufacturers which in 1945 used 285,000 tons and in 1950 used 400,000 tons of steel, estimates that in 1960 its steel requirements will total 840,000 tons. Such growth on the part of industry can only result in utilization of all of this added capacity.

In predicting future new capacity, President Truman's Materials Policy Commission estimated that 150,000,000 net tons of ingots and castings will be required in 1975. This will require 100,000,000 tons of pig iron. It is also predicted that steel capacity by 1960 will be 138,000,000 tons, at which time the population should be about 171,000,000. Capacity at the end of 1952 was 117,547,470 net tons due to an increase in 1952 of 8,959,800 net tons. Several additional large projects will be completed early in 1953.

To keep up with steel production, it is necessary that a constant flow of raw materials reach the steel plants.

The major additions were due to 1,200,000 tons of open hearth expansion put in operation at the Indiana Harbor works of Youngstown Sheet & Tube Co., to about 600,000 tons by U. S. Steel at the Fairless works, to about 900,000 tons by Jones & Laughlin at Pittsburgh and Cleveland, and to about 800,000 tons by Bethlehem Steel. Republic Steel increased open hearth and electric furnace capacity by 800,000 tons. Northwestern Steel & Wire increased electric furnace capacity 504,000 tons, Lone Star Steel Co. increased open hearth capacity 550,000 tons, and Inland Steel increased open hearth capacity 750,000 tons at Indiana Harbor. The Youngstown Sheet & Tube Co., however, eliminated 330,000 tons of bessemer capacity.

Early in 1953 the Fairless plant should add an additional 1,200,000 tons in addition to the 600,000 already gone into production. Pittsburgh Steel should add 325,000 tons, Detroit Steel 750,000 tons and TCI 200,000. National Steel Co., also will add capacity next year.

In proportion to their size, some of the smaller steel companies have been engaged in relatively large expansion programs. Based on the plans of 25 small companies, their combined annual steelmaking capacity was expected to rise 50 per cent in the two years up to 1953, which compares with an increase of about 12 per cent for the entire industry during these two years. These companies are also striving to attain a wider diversification in finished steel products. As an example, one company is building a new electric furnace which will make 90,000 tons of steel a year, increasing its steel capacity 48 per cent. In addition, capacity for light shapes, hot rolled strip, steel bar and wire rods is being increased, thus raising hot roll finishing capacity 32 per cent. This is typical of many such cases.

When steel plants reach their 123,000,000 ton ingot capacity in January 1954, capacity for hot rolled products in finishing mills will be about 96,000,000 tons. Thus this increase will be by about the same percentage as the increase in ingot capacity. The AISI estimated that capacities to produce hot rolled sheets on January 1, 1953 would be 28,795,770 net tons, hot rolled strip capacity would be 7,306,670 tons, cold rolled sheet capacity would be 14,464,210 tons, cold rolled strip would be 2,737,750 tons. Electrolytic tin capacity would be 3,861,610 tons. Bar capacity, not including concrete reinforcing bars, will be 13,680,790 tons.

DPA also set a goal for electrolytic tin plate at 4,100,000 short tons of annual capacity by 1955. This compares with 2,800,000 tons on January 1, 1950. Their goal for continuous galvanized sheet and strip is set at 1,300,000 short tons by 1954, which is more than double the 600,000 tons capacity available on January 1, 1950.

One result of the coming estimated balance between supply and production of steel has been disinterest on the part of some in the industry to add new capacity for some products. Industry experts estimate that the demand for large diameter bars will be satisfied within the next nine months, that for heavy plates in about another year, and supply should meet demand for structurals in about six months. Another factor is that many of the products required for defense are not normally considered profitable in a peacetime economy.

Industry has also made a drive to eliminate controls and the steel products industry advisory committee recommended on November 22, 1952, immediate open ending of the control materials plan as it affects steel. This recommendation was based on the rapid recovery of the steel industry from the steel strike. This committee estimates that there will be 118,800,000 tons of ingots produced in 1953.

The steel industry actually spent $1,304,000,000 for expansion and improvements in 1951. It is estimated that the expenditures in 1952 would total about $1,681,000,000 and planned expenditures for 1953 total $1,391,000,000.

Total steel production in 1952 was 93,149,213 net tons (third highest year) or 85.8 per cent of capacity compared with 105,199,848 tons or 100.9 per cent of capacity for the year 1951. Of this, estimated figures give a production of 82,841,790 tons for open hearth production, 3,523,306 tons of bessemer production, and 6,784,117 tons of electric steel production. Finished steel output totaled about 68,500,000 tons. Total pig iron production for the year 1952 is estimated at 62,000,000 or 85 per cent of capacity compared with 71,232,761 tons in 1951. Estimated production for 1952 includes about 630,000 tons of ferromanganese and spiegel. 1952 figures were far below those for 1951 because of the loss of production due to the various steel strikes during the year, and it was estimated that about 19,000,000 tons of raw steel production were lost due to the strikes. During the steel strike, production dropped to as low as 12½ per cent of capacity. The strike lasted 54 days and ended on July 26. It was estimated that each employee averaged an individual loss of more than $650.

Concurrently with the wage settlement, the government authorized an average increase in carbon steel price ceilings of $5.20 a ton or about ¼¢ a lb. This increase consisted of $2.84 a ton previously authorized under the Capehart Amendment because of cost increases incurred prior to July 26, 1951, plus 70¢ a ton to cover a freight rate increase which became effective on May 2, 1952, and an additional $1.66 a ton. This latter figure was what was allowed for the increased employment costs resulting from the wage settlement. An interesting feature of the settlement contract is the union security clause which was included. Under this, each new employee when hired, signs an application card to the union which does not become effective for thirty days and will not become effective if it is revoked by the employee during the last fifteen days of the thirty day period following his employment. For employees or union members there is a withdrawal privilege which gives them a right to drop their membership during the last fifteen days of the new contract if they so desire. Present employees who are not now members do not have to join the union. The contract also provided for wage increases averaging 16¢ an hr by increasing the first job class rate by 12½¢, and increasing the spread between the higher job classes by ½¢. This increase was retroactive to March 1, 1952. Other terms included an increase in shift differentials to 6¢ an hr for the afternoon shift and 9¢ for the night shift from the present 4 and 6¢, and a reduction of the southern differential from 10¢ to 5¢ an hr.

After the steel strike, the current average rate for steel is $2.04 an hr according to the Bureau of Labor Statistics. The statistics of the American Iron and Steel

Institute, however, show that during the year, average hourly earnings rose to new high levels. At the beginning of 1952, the average was about $1.958 an hr. In September this was up to $2.206. The payroll in September was higher than any previous month at $269,000,000. Total payroll for the year was about $2,900,000,000 or practically as high as in 1951.

Net earnings in 1952 for the steel industry as a whole were lower than 1951 which in turn was lower than 1950. This was primarily brought on by the heavier tax burden and higher operating costs. In general steel company earnings were adversely affected because of the steel strikes which occurred. In a few cases, tax carrybacks resulted in earning records which were better than 1951.

The steel industry was also beset and plagued with rising prices and this was very apparent in their construction programs. In some cases additional work has been held in abeyance because increased costs have raised estimates above those originally budgeted. At one company new construction runs 20 to 40 per cent above the estimates made when projects were started two years ago. A substantial portion of this was the result of premium overtime payments which were necessary to induce the men to work.

It is estimated that the July wage settlements will eventually boost steelmaking costs about $10.00 a ton. As one item, iron ore prices went up 75¢ a ton. With the increase in steel mill construction costs it has been estimated that steel prices should go up a total of about $20.00 a ton. One factor which will increase steel producing costs is the $1.90 per day increase in wages which the mine workers won during the year. This will raise steel costs approximately 60¢ a ton.

Taxes are still a terrific item of expense in the steel company budget. In 1951, over $1,400,000,000 were paid in Federal taxes. This figure is $500,000 more than in 1950. Local, state and miscellaneous taxes incurred by the iron and steel industry in 1951 were over $162,000,000. These figures do not include social security and similar employee benefits.

Rail rates also went up on May 2. This rise will put distant mills at a freight disadvantage. The average over the country for the increase in rail rates is about 6.8 per cent above the old tariffs. This railroad rate increase completed the 15 per cent which the railroads had been after for several years and include a 9 per cent boost in the south and west, and a 6 per cent increase in the east. This freight increase will result in freight costs for the steel producers of $1.30 to $1.65 per ton since January 1951. The cost to consumers is even greater and is estimated at from $1.40 to $1.75 per ton.

An interesting milestone in steel production was attained during the year when the United States Steel Corp. poured its 1,000,000,000th ton of steel on November 26. This company produced almost 29,400,000 tons of steel in 1952 in spite of the 54 day old strike, which caused a loss of about 7,000,000 tons from U. S. Steel mills alone. In spite of this loss, production is the sixth highest in the history of the corporation, and is only 4,900,000 tons less than the all time record in 1951.

On January 1, 1953 papers were filed for dissolution of the United States Steel Co. The United States Steel Corp. thus becomes an operating company instead of a holding company. Another change in management policy is that Mr. B. Fairless alone is head of the company and no triumverate will be at the head as has been the policy for a number of years.

United States Steel Corp. set a record this year when it poured its 1,000,000,000th ton of steel.

One interesting development in the steel industry is that a number of companies have gone into production on titanium and titanium alloys. Republic Steel Corp. announced during the year that it is working on the new metal. It thus joins Crucible Steel and Allegheny Ludlum in this field. Republic melts titanium at Canton, Ohio by both the arc and induction methods. It is believed that the arc melted product will find the most widespread application. The firms now interested in this business include Allegheny Ludlum Steel Corp., a part owner of Titanium Metals Corp., Crucible Steel Co. which is interested in the Rem-Cru Titanium Corp., Republic Steel Corp., and Mallory-Shar Titanium Corp. which is a subsidiary of Sharon Steel.

DETAILED EXPANSION PROGRAM

The largest amount of attention on the expansion program has been centered on the new Fairless works of the United States Steel Corp. which will have a capacity of 1,800,000 tons from nine 275-ton open hearths. This plant will also have two blast furnaces which will produce 1,134,000 tons of iron. Two batteries of coke ovens will each produce 932,000 tons of coke. Estimated capacities of finished steel for the facilities now under construction are 235,000 tons of hot rolled sheet, 178,000 tons of tin mill product, 289,000 tons of cold rolled sheets, 281,000 tons of steel pipe and 285,000 tons of bars.

The two blast furnaces at this plant are both 28-ft hearth diam and should produce better than 1500 tons a day. Both units are equipped with two electric precipitators for cleaning the gas down to about 0.01 grains

per cu ft, which in turn will be used for firing boilers in the power house and in the blast furnace stoves. Electrostatic precipitators have also been installed on all the open hearths to guard against air pollution. Each furnace has twin units so that one may be shut down for maintenance while the other is in operation. Layout has been such as to make material handling most economical. Ingot sizes at this plant will range from 32 to 78 in. wide, and 22 to 38 in. thick and from 75 to 95 in. long. Maximum weight will be about 32,000 lb. On December 11, the first blast furnace was lit, and the first open hearth tapped. Coke was pushed from the first of the two 87-oven batteries on December 9.

The basic equipment in the rolling mills consists of a 45 × 90-in. universal slabbing mill with a capacity of about 3,000,000 tons per year; an 80-in. hot strip mill with a capacity of about 3,200,000 tons per year; a 40 × 96-in. 2-high reversing blooming mill for making 9 × 9-in. blooms, 11 to 18-in. slabs by 7 in. thick, with an annual capacity of 3,000,000 tons; a 30-in., 6-stand continuous billet mill and a 21-in., 4-stand continuous billet mill; and an 18-stand, 10-in. continuous bar mill with an annual capacity of 500,000 tons. Designs have been so set up as to minimize roll change time. Because of the large capacity built into some of the mills such as the large slabbing mill, it is estimated that greater reductions can be obtained and fewer passes required. The number of passes may be reduced to about 15 from the usual 21.

Among the cold reduction facilities is a 4-stand mill and a 5-stand mill for reduction of the strip into tin plate. The 5-stand mill will roll tin plate at a speed of 7000 fpm and handle stock up to 30 in. wide.

The National Tube division will operate as a separate unit although it will obtain slabs for its 15-stand skelp mill from the Fairless works. This plant will have two continuous butt-weld mills with a capacity of 281,000 tons of ¼ to 4-in. standard pipe.

The Fairless works has been running somewhat behind the original construction schedules, and at the end of the year was 75 per cent complete. The whole unit should be finished sometime in the third quarter of 1953.

One of the problems which this plant must face is that although it is a tidewater mill, it is not located on deep water. Delay in the dredging of the channel of the Delaware River means that for some time to come, ships with drafts over 25 ft, cannot go to the plant. The corporation has requested that the channel be dredged to 35 ft. Actually, the present channel does not come up to the present authorized 25 ft.

The Orinoco Mining Co. is rushing facility installations at Cerro Bolivar and shipments of Venezuelan ores are expected to start early in 1954. The vessel dock at Puerto Ordaz is now in operation.

United States Steel Corp. has under way an extensive program of rebuilding coke oven batteries. In this program twelve batteries are involved, six at Clairton, Pa.; two at Cleveland, Ohio; one at Lorain, Ohio; two at Gary, Ind.; and one at Duluth, Minn. At the end of 1952 four of these batteries were either complete or practically completed.

The new blast furnace for the American Steel & Wire division at Cleveland, Ohio is scheduled for initial operation in the second quarter of 1954.

In September, National Tube division of U. S. Steel initiated work at their Gary, Ind. plant for the extrusion of high alloy seamless tubing and solid shapes by the Ugine-Sejournet process.

In the expansion program scheduled by the TCI division, their open hearth units will be closed down in pairs and rebuilt, increasing their present capacity per heat from 190 to 210 tons. Various auxiliaries must be modified to handle this additional capacity. As an example, replacement of the present riveted ladles by welded ladles will give a 5-ton increase of capacity.

TCI has six blast furnaces at its Ensley, Ala. works, and three at the Fairfield works with an annual capacity of 2,500,000 tons. By using an enriched mixture of red mountain ore and Venezuelan ore, it is estimated that this capacity can be raised about 400,000 tons. For this, an ore terminal will be required at Mobile, Ala., and this is now under construction. Some of this ore will be shipped in by barge, but the majority will be shipped in by rail to the plant.

On the Bethlehem Steel Co. expansion program are two new blast furnaces for the Bethlehem plant as well as one battery of coke ovens at this location. These are 600,000-ton annual capacity units. The first is scheduled for February 1953 and the second soon thereafter. A battery of coke ovens is also scheduled for the Sparrows Point plant. Slated for Lackawanna plant, was a battery of coke ovens, a blast furnace, four open hearth furnaces, four groups of soaking pits. Most of this went into operation in 1952. Construction program at the Johnstown plant includes a battery of coke ovens.

Bethlehem Steel Corp. since the end of World War II has added 5,600,000 tons of annual capacity giving a resultant 18,500,000 tons. This is divided into about 6,000,000 tons at Sparrows Point; 5,000,000 tons at

New blast furnace of Pittsburgh Coke and Chemical Co.'s Neville Island plant started operation on December 12. Photograph shows furnace under construction.

Buffalo; 3,200,000 tons at Bethlehem and 1,300,000 tons at Steelton. Total pig iron capacity is now about 12,400,000 tons.

Speculation on the future of the steel plant which had been proposed for New England was pretty well eliminated in the report made by Arthur D. Little, Inc. to the Federal Reserve Bank of Boston. This report indicated that instead of a large 1,000,000-ton integrated steel plant, New England should actually have a small specialty steel unit which would cost about $14,000,000 instead of the integrated plant's $250,000,000. This newer unit would have an electric furnace instead of open hearths. The large steel plant has definitely been abandoned and the certificates of necessity allowed to lapse.

The first heat from the last of the four new open hearth furnaces of Republic Steel Corp.'s $75,000,000 expansion program was poured in November. Republic Steel Corp. completed in the Cleveland district two 63-oven coke batteries, a 1440-ton blast furnace, four open hearth furnaces, improved their blooming mill facilities and substantially increased their cold rolled sheet and strip capacity. These units will add 672,000 tons to Cleveland's annual ingot capacity.

In the Chicago district they completed facilities to make seamless tubing and casing. At Birmingham a 65-oven coke battery was completed.

The capacity of Jones & Laughlin Steel Corp. has increased from 4,741,500 tons right after the war to 6,406,500 tons on January 1, 1953. Principal improvements for J & L included new open hearth furnaces at Pittsburgh works, an electric driven blooming mill at Pittsburgh which rolls larger ingots than J & L has ever been able to roll before, an electrolytic tinning line at Aliquippa, and a 59-oven coke battery at Aliquippa.

In 1953 J & L expects to complete a 79-oven coke battery in Pittsburgh, electrification of the steam driven blooming mill at Aliquippa, improvement of the 14-in. hot mill at Aliquippa. In addition, the corporation is putting into production a new bar mill at its Pittsburgh works about January 1, 1953. This mill will have an annual capacity of 360,000 tons in the size range of 19/64 to 1¼ in. rounds, with comparable sizes in other shapes. Pittsburgh works also set up plans for producing steel sections by the Ugine-Sejournet hot extrusion process.

The Jones & Laughlin Steel Corp.'s $59,000,000 expansion program at its Otis works included a 1300-ton blast furnace which was blown in on April 29, and an additional two 210-ton open hearths.

At Youngstown Sheet & Tube Co.'s Indiana Harbor plant, all of their new eight open hearths (1,250,000 ton annual capacity) were completed at about the end of the year. These are rated at 250 tons, but are producing around 265 tons a heat. The first coke from their new 75-oven coke plant was pushed in November. The new 28-ft blast furnace should start production early in 1953. The company discontinued operations on its bessemers.

In September Inland Steel Co. put into operation the first of its four new open hearth furnaces at its Indiana Harbor works. The remainder were put into operation by the end of the year. These four units, of 250-ton capacity, bring to 40 the total of steelmaking furnaces at this plant, and increase the annual capacity of the plant from 3,750,000 tons to 4,500,000 tons.

National Steel Co. put two new blast furnaces into production on September 22. These two furnaces will add a total of about 1,000,000 tons a year to the pig iron capacity of National Steel. One of these units will be the No. 4 blast furnace at Weirton Steel, and the other unit will be the fourth furnace at Zug Island plant of the Great Lakes Steel Corp.

Also under construction is a battery of 70 coke ovens, a 45 × 90-in. slabbing mill and two 25-ton bessemer converters at the Great Lakes Steel Corp. Existing open hearth units are also being enlarged to add 350,000 tons in 1953.

The DPA approved federal tax assistance for a proposed $24,750,000 expansion program for Weirton. This program will consist of two batteries of 41 coke ovens each, extension of coal handling facilities, five additional barges and other miscellaneous units. The extension will provide capacity to carbonize 2000 tons of coal every 24 hours.

The new blast furnace and coke plant for Armco Steel Corp., at Middletown, should be in operation by March. This will raise capacity at this plant about 15 per cent.

The Armco Steel Corp. will also spend $20,000,000 at Ashland, Ky. to build a cold reduction mill, a continuous cold strip pickler, and a light and heavy gage zinc grip line.

On December 12, the Crucible Steel Co. lit a 1000-ton a day, 25-ft hearth diam blast furnace at Midland, Pa. This project cost an estimated $12,000,000.

A new 24-in. bar mill, and a new battery of 29 coke ovens were also put into operation. This brings the number of ovens up to 213.

Pittsburgh Coke and Chemical Co. is in the middle of a $20,000,000 expansion program. They placed into operation October 7, a new battery of 35 coke ovens at their Neville Island plant in Pittsburgh, Pa. This battery is in addition to the existing 105 ovens. Another item on their program, a new blast furnace at Neville Island, went into operation on December 11. This adds 300,000 net tons to the company's present capacity of 470,000 tons of pig iron.

Another program which has gone along nicely is that of the Granite City Steel Co. This is a $40,000,000 program scheduled to be completed in 1953, which will add more than 500,000 ingot tons to the company's open hearth capacity of about 750,000 tons. Their new program includes addition of three new open hearth furnaces, a new 46-in. blooming mill, new soaking pits, a new four-high reversing mill, and new slab furnaces. The company purchased a blast furnace and coke plant from the Koppers Co. in 1951.

Among other programs, at Owensburg, Ky., the Green River Steel Corp. will obtain about 200,000 tons yearly capacity from two new electric furnaces which are scheduled to come into operation in January 1953. The Newport Steel Corp. at Newport, Ky., is getting an additional 144,000 net tons of yearly capacity with one new electric furnace and conversion of an existing electric furnace. Pittsburgh Steel Co., Monessen, Pa., will get 168,000 net tons of capacity in June 1953 through enlargement of an open hearth. The Seidelhuber Steel Rolling Mill Corp., of Seattle, Wash., will have

150,000 net tons of capacity go into operation in 1954 from a new electric furnace. Tennessee Steel Corp., at Oneida, Tenn., will get an annual capacity of about 228,000 from three electric furnaces which will go into operation in December 1953.

Among the larger rolling mill units, Armco Steel Corp., at Ashland, Ky., added a 100-in. slabbing mill and a 10-stand hot strip mill which went into operation in December. At the Carpenter Steel Co. at Reading, Pa., a hot bar mill also went into operation in December. Colonial Steel Co. of Monaca, Pa. put into operation a 22-in. bar mill in November. Connors Steel Co. of Birmingham put into operation an 18-in. mill in July. Detroit Steel Corp. at Portsmouth, Ohio put into operation a 54-in. hot strip mill in the third quarter, and a 54-in. cold sheet mill in the fourth quarter. At Mansfield, Ohio, Empire Steel Corp. put into operation a 42-in hot strip mill in August 1952. This replaces the mill on which sheet bars were rolled and this company is thus going out of the sheet bar business. Kaiser Steel Corp., at Fontana, Calif., put into operation their 44-in., 5-stand, 4-high cold reduction mill and 44-in. 4-high temper pass mill in May 1952. Keystone Steel and Wire Co. put into operation a 3-stand, 21-in., billet mill in Peoria, Ill. in December 1952. Latrobe Steel Co., put into operation a 12-in. bar mill in December 1952. It was reported that a 144-in. plate mill was put into operation at Long Vue, Tex., by R. J. LeTourneau Inc. in October. Northwestern Steel and Wire Co., at Sterling, Ill., put into operation a 46-in. blooming and slabbing mill in October 1952. At Cleveland, Ohio, Republic Steel Corp. put in a 72-in. cold reducing tandem mill. J. A. Roebling Sons Co. at Roebling, N. J. converted a 2-strand continuous rod mill to a 3-strand mill in October 1952. The Seidelhuber Steel Rolling Mill Corp. put into operation a bar mill in the fourth quarter of 1952. At Huntington, W. Va., the West Virginia Steel and Manufacturing Co. put into operation a 28-in. blooming mill in November.

Mills still scheduled for completion include a tube mill for Colorado Fuel and Iron Corp. at Pueblo, which is scheduled for June 1953. Continental Steel Corp., at Kokomo, Ind., has a continuous wire rod mill scheduled for the first quarter of 1953. Detroit Steel Corp. at Portsmouth has a 48-in. high lift bloomer scheduled for the second quarter of 1953. The Granite City Steel Co. at Granite City, Ill., has a 46 in. blooming mill scheduled for January 1, 1953 and a 4-high reversing mill for April 1953. At Owensburg, Ky. the Green River Steel Corp.'s blooming and bar mill is scheduled for January 1953. The blooming and slabbing mill and a hot strip mill for the Lone Star Steel Co. is scheduled for March 1953. Newport Steel Corp.'s 3-stand tandem cold mill at Wilder, Ky. is scheduled for 1954. Pittsburgh Steel Co.'s 66-in., 4-high hot sheet and strip mill is scheduled for May, 1953, and the 4-stand tandem cold sheet and strip mill for July 1, 1953. A 32-in. 2-high reversing blooming mill is scheduled for completion in late 1953 by the Sheffield Steel Corp. at Kansas City, Mo. The Tennessee Steel Corp., at Oneida, Tenn., has strip, skelp, pipe, bar and rerolling mills scheduled for December 1953. Youngstown Sheet & Tube Co. has a blooming mill at Indiana Harbor, Ind. scheduled for July 1953 and a continuous cold strip mill for April 1954. In addition to the above, a number of the mills at the Fairless works will go into operation in this coming year.

At the end of 1952, Lone Star Steel Co.'s program was pretty well under way. The company's older facilities included a blast furnace, a coke oven, iron ore mines ore beneficiation plant, a cast iron pipe foundry. Their new $75,000,000 expansion program will add four new open hearth furnaces, a skelp mill, two electric weld pipe mills. This company is set up primarily to serve the oil industry. This company was among the firms which received defense funds for expansion, and received an additional loan of $50,650,000 for development facilities for producing additional pig iron and coke. The Kentucky Steel Corp., at Newport, Ky., was authorized $200,000,000 for working capital for construction program which includes coke ovens, blast furnaces, blooming and hot strip mills, open hearth furnaces and cold rolling equipment. Central Iron and Steel Co., Harrisburg, Pa. and Phoenixville, Pa. was authorized $55,950,000 for working capital and construction of coke ovens, blast furnaces, open hearths and mills. The Trenton Steel Corp., Detroit, Mich., was authorized $50,000,000 for construction of blast furnaces, coke ovens and ore docks. The Detroit Steel Corp. was authorized $45,000,000 to aid an expansion program which include blast furnaces and construction of finishing facilities.

At the end of the year, the Follansbee Steel Corp., asked the RFC for a $29,500,000 loan to build facilities for manufacturing its own hot rolled steel. At the present time the company is depending on outside producers for hot rolled steel supplies.

A newly formed company this year is the Niagara River Steel Corp. which plans to build a $40,300,000 pig iron and coke plant near Buffalo, N. Y. Units will include a blast furnace, a by-product coke plant, and power generating equipment.

Another new company was established to build a blast furnace for the production of merchant pig iron in Michigan, to be completed early in 1954. This new firm, the Michigan Iron and Coke Co., of Detroit, has started construction work on a blast furnace and coke oven installation which will be located 2½ miles south of St. Clair, Mich. Plant will be capable of producing 300,000 tons of merchant pig iron and 350,000 tons of coke annually. Estimated cost is $25,000,000 to $30,000,000.

Plans for the construction of the Yolo Steel and Metal Corp. of Sacramento, Calif., were scaled down considerably from the plans announced a year ago. Present plans consist primarily of a blast furnace which will produce about 1000 tons of pig iron a day, and coke oven facilities. These facilities are estimated to cost $44,000,000, for which the government issued a certificate of necessity. A steel mill which will produce 660,000 tons a year is on the program for the future. This plan is considerably below the initial 1,000,000 tons a year steel plant which was originally discussed. The ore is expected to come from a newly developed mine located near the lake backed up by Shasta Dam.

The new North American Steel Co. now plans a $66,000,000 plant. This plant is to be located in Camanche, Iowa, a small town outside Clinton. The initial program for this plant consists of two blast fur-

naces with an annual capacity of 1,000,000 tons, and 96 coke ovens. The company also owns a 25-in. billet mill purchased from the government several years ago.

The future for steel in the west looks very good. This area uses about 13,500,000 tons annually and makes only about 6 per cent of the total. This 6 per cent of the total is actually about 6,200,000 tons. Steel producers in this area feel that the population growth and mounting freight rates combine to assure the future of western steel.

Kaiser Steel Corp. started work on a third blast furnace during the year, and completed its ninth open hearth (156,000 ton capacity). The blast furnace which will have a capacity of 438,000 tons of pig iron will be completed in the spring of 1953. The third blast furnace of the Kaiser Steel Corp. will be similar to the previous two furnaces. One reason for its construction is the shortage of scrap in the area, which the company believes will become worse over the next few years. Also planned are 90 coke ovens, of the Koppers-Becker type which will produce 408,000 tons of coke a year. Eventual completion of present plans will give the Kaiser Steel Corp. an ingot capacity of 1,536,000 tons and pig iron capacity of 1,300,000 tons per year. This program is now scheduled to be completed in the spring of 1953.

FOREIGN PLANTS

The international steel map is being gradually redrawn. Although the United Kingdom, France and Germany, the three leading countries in free Europe are attempting to better their steel position, the smaller countries which include Belgium, Luxembourg, the Saar, etc., are doing a better job in this respect. Free Europe produced about 69,000,000 net tons in 1952, which is approximately 95 per cent capacity. Russia and her satellites produced about 50,000,000 net tons of steel in 1952. See Table I for detailed data.

After the ratification of the Schumann Plan, it had been expected that there would be a radical revision of sales policies in Europe and the fast establishment of a joint sales organization. However, even some time after the plan had been approved, sales procedures were still operating as previously. Apparently all member companies are anxious to see the working of the combine postponed as long as possible.

Under the plan France, West Germany, Italy, Belgium, Holland, Luxembourg are to set up boundaries for a common market and to divide production according to the most efficient and most economical source, regardless of country and also divide up the available raw materials. Their aim is to have a common market without a common currency. In the initial operation of the Schumann Plan, one of the hitches is that many European customers are refusing to place orders with the central sales office at Luxembourg unless they are given the right of specifying the producer. This is contrary to one of the basic assumptions made by the planners of the pool and that is that the supply and distribution of the products would be determined by geographical location with producers servicing customers located nearest them. In the latter part of the year export prices of European steel dropped appreciably although domestic prices are rising. This drop is an indication of the competition for export business by Schumann Plan members. This is primarily due to maneuvering for position when the export quotas are handed out. Price cuts range from $5 to $12 per ton.

TABLE I

World Steel Production and Capacity Estimates With Estimate for 1953 Output

Thousands of Net Tons of Crude Steel — Add 000

	Annual capacity January 1, 1952		Output 1951	Estimated output 1952	Estimated output 1953
	Tons	World per cent			
United States	108,592	43.69	105,140	93,100	117,700
Canada	4,409	1.78	3,567	3,800	4,950
Latin America(1)	2,067	0.83	1,814	2,000	2,772
Total 6 American countries	115,068	46.30	110,521	108,900	125,422
United Kingdom	20,062	8.06	17,516	17,900	19,800
France	11,299	4.55	10,836	12,000	16,280
Saar	3,031	1.22	2,867	3,130	
West Germany	18,739	7.54	14,884	17,340	15,950
Belgium	5,787	2.33	5,516	5,450	6,050
Luxembourg	3,582	1.44	3,393	3,300	3,520
Sweden	1,929	0.78	1,657	1,750	2,255
Italy	3,858	1.55	3,362	3,850	3,410
Other free Europe(2)	4,136	1.67	3,664	4,000	4,774
Total free Europe	72,423	29.14	63,695	68,720	72,039
Japan	9,094	3.66	7,167	7,770	7,590
Other free Asia, Africa(3)	5,126	2.06	4,330	4,730	5,610
11 Small countries(4)	303	0.12	209	.....	(6)
Total miscellaneous	14,523	5.84	11,706	16,500	13,552
Russia	34,722	13.97	34,502	38,600	41,470
Satellites(5)	11,795	4.75	10,088	11,840	13,750
Iron Curtain Total	46,517	18.72	44,590	50,440	55,220
Est. world total	248,531	100.00	230,512	230,458	266,453

(1) Argentina, Brazil, Chile, Mexico; several small countries not included.
(2) Austria, Netherlands, Norway, Switzerland, Turkey, Finland, Spain, Yugoslavia.
(3) Australia, India, Union of South Africa.
(4) Colombia, Peru, Uruguay, Venezuela, Denmark, Greece, Ireland, Portugal, Thailand, Algeria, Morocco.
(5) Czechoslovakia, East Germany, Hungary, Rumania, Poland; data on Far Eastern satellites unknown but capacity small.
(6) Probably well above 352,000 tons but not estimated for several countries.

Sources: 1951 output and 1952 capacity from Iron and Steel Division, NPA.
Output for 1953 estimated by United Nations in report dated April, 1952.

A big help in British production is the modernized Margam Steel Works, Abbey Works and Trostre Tinplate Mills of the Steel Co. of Wales. These are the first units completed of Great Britain's $700,000,000 steel improvement program. Most tinplate manufacturing in Great Britain is in South Wales where they still rely on pack-mills for more than 70 per cent of their output. The new tinplate mills will make obsolete much of this equipment.

The work at Margam called for a rebuilding and enlargement of blast furnaces and coke ovens to produce a greater quantity of pig iron and enlarging six 60-ton open hearths to 80-tons. Built at the Abbey works is an 80-in. continuous hot strip mill, and a melting shop with eight 200-ton oil-fired open hearths. Here also, six 60-ton open hearths were increased to 80 tons. A 5-stand tandem cold mill, two 2-stand, 48-in. temper mills, annealing and plating units were installed at Trostre. The tinplate capacity of Trostre is 140,000 boxes of tinplate weekly, for which it gets 7000 tons of hot rolled strip from the Abbey works.

The first steel from a new melt shop at John Summers & Sons Ltd., Shotton, England was poured last August. This shop is part of $47,600,000 expansion program. The first of two new 44-oven coke batteries started in October and a new 27-ft hearth blast furnace was put into operation.

Production in Great Britain of pig iron was at annual rate of about 12,000,000 net tons. This was appreciably greater than the total 10,829,000 net tons produced in 1951. Part of this increase was due to the five new blast furnaces which were put into production. Steel production in Great Britain was 17,900,000 net tons in 1952.

An important event for the steel industry of Great Britain was the bill which was introduced into Parliament by the Tories to return the steel industry to private ownership. This bill still keeps the industry under heavy government control. Although there is a strong desire to return the industry to private ownership, it will be very difficult proving that once a socialistic experiment has been undertaken, it is difficult to reverse. Under the proposed bill, an iron and steel board will be set up which will have the power to fix maximum prices. In addition, the board will discuss programs with the firms so that each company's operation can fit into the overall plan for the industry. The board can stop the company from carrying through a project which the board feels is injurious to the country. It can also recommend additional capacity to the industry. The board will also have a supervisory role over raw materials. If necessary, the board can ration and distribute such raw materials. Under the bill the Iron and Steel Corp. of Great Britain, the present government unit, will be dissolved and holdings transferred to a holding agency, who in turn will dispose of the securities subject to a treasury approval. Another problem which must be overcome is due to the fact that the labor party has threatened to renationalize the industry, when they obtain power, under terms which will not be quite as favorable as before. This threat will make many an investor hesitant before he buys shares in the new British concerns.

The 1,000,000-ton hot strip mill under construction by Sollac went into operation in the fall. By next spring, all of this unit's $147,000,000 worth of facilities will be in full operation. Equipment at this new French works, located at Hayange and Ebange, both of which are only a short distance from the Saar, will include a 45 × 114-in. blooming-slabbing mill, a 48-in., 5-stand tandem cold reducing mill, an 80-in., 3 stand cold reducing mill, and necessary temper mills, coil conveyors, pickling lines, etc.

Record steel production took place in France and about 12,000,000 tons of steel were produced compared with 10,818,500 tons in 1951. Steel output in the Saar was 3,130,000 tons in 1952, compared with 2,863,300 tons in 1951. In spite of these gains in production, plans are being studied which will bring French plus steelmaking capacity in the Saar to about 23,000,000 tons. A bill will be presented to the French Parliament in which estimated cost is $1,280,000,000.

The city of Ymuiden is becoming the steel center of Holland. This city, located on the North sea and the North Sea Canal, has become a center of expansion. A $50,000,000 program has been under way, which is now at its midpoint. When completed Ymuiden will be able to turn out 600,000 tons of sheet and about 75,000 tons of steel plate. All three blast furnaces are being modernized. In 1951 this plant produced 524,000 long tons of pig iron, plus 285,000 tons of finished steel products. The expansion program includes a 500,000-ton annual capacity blooming mill, a semi-continuous hot mill which will replace the present hand sheet mills, plus cold rolling mill and tinplate facilities.

Upon completion of new bessemer facilities at Linz Donnewitz, Austria, Austrian steel capacity will be raised 300,000 tons to 1,300,000 tons. Production of steel in Austria in 1951 totalled slightly over 1,200,000 tons, and iron production totalled about 1,300,000 net tons.

The exact position of Russian industry and industrial potential is subject to some guess work as exact details cannot be obtained. However, it was estimated that in 1952, steel production in the Soviet bloc was 50,500,000 net tons compared with 69,000,000 tons in Western Europe, and 93,100,000 tons in the United States. Also Russia produced about 473,900,000 tons of coal compared with 520,000,000 tons in Western Europe and 540,000,000 tons in the United States. These figures for Russia do not include Red China. Under Russia's expansion program, the Red bloc is slated to produce 68,000,000 tons of steel by 1955, which should be very close to what western Europe is able to do. Russia's share in 1955 is scheduled at 54,000,000 tons of steel.

Georgi Malenkov in his speech before the all-union Soviet Communist party Congress in Moscow stated that production of steel in 1952 would be 38,600,000 net tons of steel ingots (about twice 1947), 27,500,000 net tons of pig iron, and 29,700,000 net tons of rolled steel products.

Steel production capacity is on the rise in Latin America. At the present time, only Brazil, Chile and Mexico have integrated steel industries. Under construction are integrated mills at Colombia and Peru. Argentine is expanding its rolling mills. Venezuela has plans for expanding its rolling capacity. Existing capacity on January 1, 1952 was 1,833,700 tons of steel. With present construction program, South America will add 709,000 tons to reach about 2,500,000-ton capacity between 1953 and 1955.

The largest producer is Brazil which produces now about 700,000 tons of finished steel. Mexico has an annual capacity of about 290,000 tons of pig iron, and 550,000 tons of ingot capacity. At completion of present construction program, Brazil's ingot capacity will be about 1,000,000 tons per year.

An additional blast furnace and two new open hearth furnaces will be completed in Brazil at the Volta Redonda plant in December 1953. This program in-

cludes additional rolling facilities and some additional coke oven capacity. The biggest expansion program in Brazil is at the National Steel Works. Its ingot capacity is going up from 330,000 to 513,700 tons.

Under consideration in Colombia is a 120,000-ton capacity plant in Paz de Rio for the production of bars, wire and wire products, etc. The new steel plant in Peru which is under construction will have a capacity of 38,000 tons of bars, light sections and wire, and 15,000 tons of sheet. The plant in Peru contemplates two pig iron and two steel furnaces, each with a capacity of about 100 tons of metal per day. Electric furnaces will be used both for reduction of ore to pig iron, and for the conversion of pig iron into steel.

Under discussion in Argentina is a new steel works to be located at San Nicolas near Rosario. This plant contemplates an ingot capacity of 748,000 tons annually, and will consist of a blast furnace and six open hearth furnaces. An integrated steel plant contemplated for Venezuela contemplates the use of a Swedish sponge iron process.

In the Far East, the Marcello Steel Corp. increased its annual capacity to 40,000 metric tons. This plant is located in Manila, Philippine Islands. The plant consists of three electric furnaces and ingot breakdown mill and a rerolling mill. The plant was bought from Japan. The rolling mill is dependent primarily on war surplus scrap. The Philippine government is also planning to enter the steel business with the construction of a $3,500,000 plant at Iligan, Lanao which is near the iron ore deposits at Mindanao.

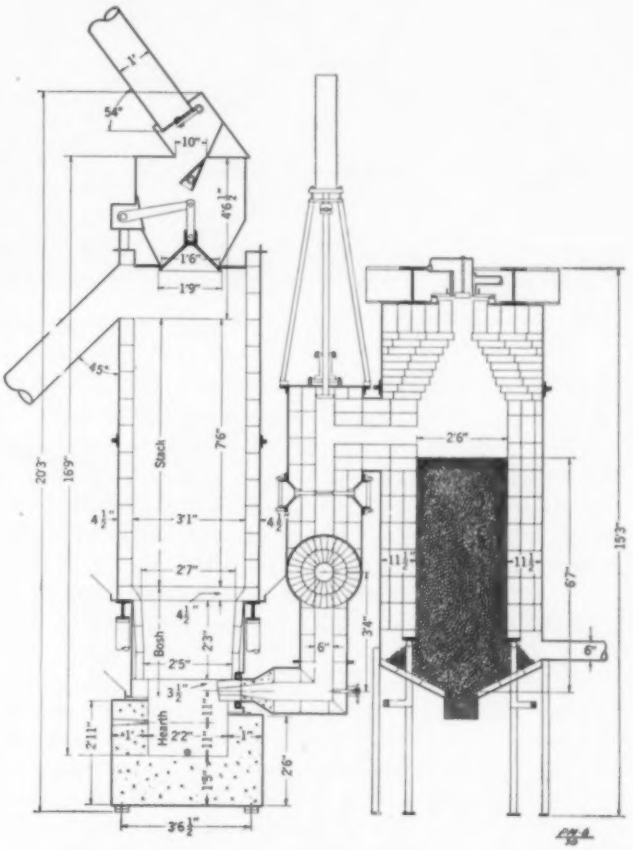
At the end of the year, the world bank advanced $31,500,000 to back three projects for India which will push India's steel capacity from 1,100,000 long tons to 2,000,000 long tons. These include expansion and modernization of the Indian Iron and Steel Co., Ltd., Bengal which will expand finished steel capacity from 350,000 tons to 700,000 tons and increase blast furnace capacity from 640,000 tons to 1,400,000 tons. Tata Iron and Steel Co. plans to boost finished steel capacity from 750,000 tons a year to 930,000 tons, and plans to build a strip mill and tube mill, at a cost of about $65,000,000. The third Indian project is still in the planning stage. It is for a new steel plant with 350,000 tons finished steel capacity. This plant would be owned jointly by the Indian government and private foreign interest.

RAW MATERIALS

The giant appetite for raw materials by the steel industry was demonstrated by figures given by the American Iron and Steel Institute for the quantities used in 1951 to produce 105,000,000 tons of steel. It required 130,000,000 tons of iron ore; 100,200,000 tons of coal; 68,000,000 tons of coke; 2,500,000,000 gal of fuel oil; 284,000,000 gal of tar and pitch; 207,000,000,000 cu ft of natural gas; 27,611,000,000 kwhr; 36,000,000 tons of limestone; 58,000,000 tons of scrap, of which the steel companies produced 33,000,000 tons in their own operations and purchased 24,000,000 tons. Thus the average charge into the open hearth consisted of 45 per cent scrap and 55 per cent pig iron.

On the other hand the steel industry used less copper than any year since 1947 with 57,499 tons. It used 17,742 tons of lead, 37,367 tons of tin (down 12 per cent), although tin plate was down only 3.2 per cent. This latter variation is primarily due to the industry's conservation program and the increasing use of electrolytic tin. The industry used 228,600 tons of zinc, down 51,219 tons from 1950.

A very extensive five volume report was issued during the year by the Materials Policy Commission, a special group who have studied the status of raw materials and future requirements for the American economy. Two basic assumptions were used in this study, one that working force in 1975 would be 82,000,000 and second that man-hour productivity would increase 2.5 per cent a year between now and 1975. Based on these assumptions, it was estimated that steel would pour 147,000,000 tons of ingots and use 110,000,000 tons of products in 1975. Total consumption of aluminum would amount to 4,500,000 tons, total consumption of copper would be 2,500,000 tons. In the case of copper this is an increase of 45 per cent over 1950 and in the case of aluminum 358 per cent over 1950.



Detailed sketch shows furnace and stove developed by U. S. Bureau of Mines for smelting open hearth slag.

The Materials Policy Commission feels that coke production should be pushed and expanded. They estimate that coke capacity should be increased up to 84,000,000 tons by 1955, which is a net increase of about 10,000,000 tons, and at the end of another fifteen years, they estimate that coke requirements should be 120,000,000 tons. Much of the present coke expansion program has been covered by tax certificates and more than $677,000,000 worth is in process. These certificates cover an additional 17,500,000 tons of new capacity which will be offset by a loss of 10,000,000 tons of old capacity between 1951 and 1955.

In plant using this unit, 97 per cent of the mill scale from a hot strip mill is recovered.

More coke oven capacity was constructed in 1952 and put in operation than any other single year except 1943. About 900 coke ovens were completed with a capacity of about 5,000,000 tons. 1952 would have exceeded 1943 except for the delays brought on by the steel strike. Construction is now under way on 18 additional projects which involve 1300 coke ovens, with a capacity of about 7,000,000 tons. Most of this will be completed in 1953 so that a new production record is almost certain to be set. In addition, in 1953 work will be started on nine new projects which will involve about 600 ovens with a capacity of about 3,000,000 tons. Most of these will not be completed until 1954. All of this construction is not a net gain because of the ovens dismantled.

As of January 1, 1952, total coke capacity in the United States was 75,067,450 tons. When 1952 and 1953 projects are completed, total coke capacity will be over 80,000,000 tons. However, the goal set by the DPA is 84,000,000 tons which indicates a deficit of over 3,000,000 tons. By-product coke capacity on January 1, 1953 is estimated at about 67,900,000 or an increase of 4,700,000 tons from over the previous year. Another 1,500,000 tons should be in production before the year is out.

Previous coke figures are for all industries. Coke capacity of the steel industry was 67,060,240 net tons on January 1, 1952 (63,198,490 tons by-product in 12,811 ovens and 3,861,750 tons beehive). On January 1, 1953, steel industry coke capacity was 71,181,190 net tons. To be added are 2,400,000 tons in 1953; 900,000 tons in 1954, and 200,000 tons in 1955.

The continuing demand for raw materials and the depletion and exhaustion of high grade resources foretell a trend by industry to obtain maximum utilization and recovery from existing ores. In addition it will be necessary to develop and use much lower quality ores than are considered practical at the present time, and find uses for resources which are not now in use. Recovery of all scrap materials will be essential. Materials must be made to go further by making them work harder and longer.

Defense Production Administration set a number of new expansion goals during the year in fields which are allied with the steel industry. Taconite output will be built up to 15,000,000 tons by 1955. In addition the DPA set a goal of 147,000,000 long tons of annual iron ore capacity by 1955, which is an increase of 57,000,000 gr tons beyond that available in 1950. This capacity will be provided from domestic iron mines or from foreign mines operated by U. S. companies. By 1955, 124,000,000 tons will be produced domestically, and imports will be 23,000,000 tons. Canada will ship 8,000,000 gr tons more in 1955 than 1951, and Venezuela should ship an additional 4,400,000 gr tons.

DPA also set the manganese ore goal at 2,500,000 long tons by 1955. This will result in 630,000 long ton increase over 1950.

Among other defense expansion goals of concern to the steel industry is one for blast furnace ferroalloys which provides for an increase of 400,000 tons as of January 1, 1951 to 1,500,000 net tons on January 1, 1954. Another target set is that for electric furnace ferroalloys which has been set at 1,275,000 kw annually to be completed by January 1, 1954, an increase of 511,000 kw. The goal for steel casting facilities has been set at 3,000,000 net tons which provides for an increase of 500,000 net tons.

The present capacity of ferro silicon producers in the U. S. plus planned expansion now on the way will be sufficient to support ingot production of 120,000,000 tons in the iron and steel industry according to the NPA.

Expansion goal for tungsten is 40,000,000 lb annually to be reached in 1954. DPA set a new expansion goal for molybdenum of 70,000,000 lb of domestic production during 1954. This revised goal gives an increase of 41,500,000 lb annually over the 288,000,000 lb which was produced in 1950.

At the end of the year DPA also announced a 28 per cent boost in cobalt expansion program to a goal of 27,000,000 lb in 1955. In 1950 the U. S. supply was 10,000,000 lb while consumption was about 8,000,000 lb. Consumption in 1951 climbed to about 10,000,000 lb. The Belgian Congo is the chief foreign source for this material.

An exception to the expansion program was zinc. The DPA lowered the expansion goal for zinc by 85,000 tons. This new goal calls for a total supply of 1,245,000 short tons of zinc in 1956. This change was made because the original target was called unrealistic.

The government is pushing the development of titanium. Production in 1952 was about 2000 tons a year and DPA had set 10,000 tons production for 1955. However, at the end of the year the DPA had increased their target to about 22,000 tons a year by 1956. At the present time this metal costs from $5.00 to $15.00

per lb. Copper production, which was 928,576 tons in 1951 is expected to be 1,153,576 in 1955. Lead production which was 390,428 tons in 1951 is expected to be 426,428 tons in 1955.

One helpful factor in the raw materials situation has been the International Materials Conference group which set up allocations between the various countries in the free world. In general, supplies have eased and are not as critical as they were in 1952. In addition, the allocation work of this committee has helped channel materials where they were most needed.

The tin industry of Bolivia was nationalized on October 31. What effect this will have on the only source of tin supply in the Western Hemisphere is difficult to tell at this time.

The steel industry started the winter season with a good supply of raw materials. There have been fears that because of the steel strike and consequent strike by the men in the ore boats that insufficient ores would be transported to carry through the winter. These fears have pretty well been alleviated since the fleet carried some 74,910,798 tons down the lakes when the season closed on December 8. This was very close to the goal of 75,000,000 tons (reduced from 96,000,000 tons after the steel strike) which had been set as necessary to go through the winter. Railroads also moved about 5,000,000 tons. Liberian ore shipments in 1952 totaled 1,000,000 tons in comparison with 167,000 tons the latter part of 1951, thus inaugurating a new source of ore. Stocks of ore on January 1, 1953, were about 42,000,000 net tons compared with about 44,000,000 net tons a year ago.

The supply of scrap is also in good shape. Stocks on December 1 were a record 6,800,000 tons compared with 4,400,000 tons the year before. The drive on scrap has been virtually abandoned.

As of the last quarter of 1952 there were under construction or on order ten new vessels on the Great Lakes with an iron ore carrying capacity of 184,000 gr tons. These vessels when commissioned should be able to transport an additional 7,000,000 gr tons in a full season. Upon completion of these vessels, the Great Lakes fleet should total 288 vessels of which 23 will have been added since 1950. With the additional ore hauling capacity, a record 106,000,000 gr tons of iron ore should move down the Lakes in 1953.

The DPA also set a goal of 38 vessels for January 1, 1957 for ocean going bulk ore carriers with a capacity of about 25,000 tons each. It is estimated that these vessels should be able to haul a total of 22,000,000 long tons of iron ore and 1,250,000 tons of bauxite annually.

In spite of the increase in ore hauling capacity, some shippers say that one of the bottlenecks in ore handling will be the lack of mill storage space which they feel has not grown in comparison with their ability to haul ore. They point out, for example, that in some cases plants have encroached on their ore storage capacity in order to get additional blast furnace capacity.

DPA approved during the year the biggest single accelerated tax amortization in its history. This consisted of $298,000,000,000 for the Erie Mining Co. in Minnesota. This unit is the only one so far producing walnut sized pellets in commercial quantities. Erie Mining is planning a production rate of 5,000,000 tons by 1957, and eventual expansion to 10,500,000 tons. Some of this money will be used for an ore concentrating plant of 2,500,000 ton capacity four miles from Aurora, Minn., a sixty-mile railroad down to Schroeder on the north shore of Lake Superior, and for development of a harbor for loading the pellets into ore boats.

Erie Mining Co. is owned by Bethlehem Steel Corp., Youngstown Sheet and Tube, Interlake Iron Corp., and Pickands-Mather Co.

Reserve Mining Co., a partnership of Armco and Republic Steel Corp., rebuilt its Babbitt plant into a pilot plant with an annual capacity of 300,000 tons. It is also erecting a $75,000,000 beneficiation plant at Beaver Bay, Minn. and connecting it with Babbitt by railroad. This is scheduled for 1955 production and will be the first of four 2,500,000 ton units designed to yield a concentrate with an iron content of more than 60 per cent. Company plans to spend $260,000,000 on the project. The Oliver Iron Mine division of U. S. Steel Corp. has been conducting extensive research in taconite beneficiation and is also building a pilot plant at Mountian Iron, Minn. This will start operations in 1953 and will treat 2,000,000 tons of taconite annually to obtain 500,000 tons of concentrate. This company has also built an experimental agglomeration plant of 500,000 tons annual capacity at Virginia, Minn. Two forms of agglomeration nodulizing and sintering will be tried here.

The Humbolt Mining Co., owned jointly by Cleveland Cliffs Iron Co. and Ford Motor Co., is building two 200,000 ton per year concentrating units at the old Humbolt Mine on the Marquette range. This will be the first flotation plant for iron ore and it is expected that one unit will be producing late in 1953 and the other in 1955.

The Quebec Labrador ore development is moving right along. The company expects to start shipping iron ore in the late summer of 1954. Operation plans call for mining six months of the year during which time 2,000,000 tons of ore will be stockpiled at Seven Islands extending the shipping season at the port. The company expects to mine and ship a minimum of 10,000,000 tons of iron ore a year by 1956 and eventually up to 20,000,000 tons a year. In order to ship the 20,000,000 tons, however, the St. Lawrence seaway will be necessary.

Consideration is being given to the development of the Aquilla iron ore deposits on the west coast of Mexico. This has an estimated reserve in excess of 50,000,000 tons of 62 per cent low phosphorous and low sulphur ore.

A method has been developed by one of the mining companies to widen the range of available ore supplies. In this method, non-magnetic taconite ores are roasted and the method makes these ores magnetic which enables them to be separated by the relatively simple and cheap magnetic methods. The operation is carried out in a shaft furnace which uses a controlled atmosphere with a small percentage of reducing gas. In the roasting zone the temperature is considerably higher than the usual reducing gas which speeds up the reduction time. Since the magnetite is the only stable form of iron, if a proper ratio between carbon dioxide and carbon monoxide is maintained, such a gas will be reducing with respect to hematite and will be oxidizing with respect to both ferrous oxide and iron itself. The formation of ferrous oxide in the roasting operation is harmful since this oxide is not magnetic. By maintaining a ratio of approximately 3 parts of carbon dioxide and

one of carbon monoxide, the resulting operation can be carried on at a relatively high temperature without fear of over reduction. Most of the tests have been carried out at temperatures of 1500 to 1600 F, with the entrant gas containing approximately 5 per cent carbon monoxide and 15 per cent carbon dioxide. The balance is largely nitrogen.

A new development in the underground gasification of coal which should make this process more economical was announced during the year. In the early tests it was necessary to tunnel a hole along side the coal seam in order to get air for the formation of carbon monoxide. In the new method, an electric current is passed through the seam and this carbonizes enough coal to permit a flow of forced air to filter through the bed which produces and brings up the manufactured gas. Current flow is established between pairs of electrodes which consist of 6-in. casings sunk down to the seam. The specific heat value of gases brought up has averaged about 186 Btu.

A new development in mining consists of a coal planer developed in Germany on which tests were conducted by The Bureau of Mines. This will increase the percentage of coal that can be recovered from thin beds. The planer is a continuous mining machine that can be used in beds as thin as 24 in. The unit gives higher than average recovery.

From a survey made by The Bureau of Mines over three fourths of the coal mined in the U. S. in 1950 came from seams ranging in thickness from 3 to 7 ft. Only 7.7 per cent came from seams of less than 3 ft in thickness.

In the three years since Russia curtailed shipments of essential manganese to this country, the United States has succeeded in overcoming this curtailment by increasing imports from Africa, Asia and Latin America. India at present is the biggest source of manganese for the steel industry.

Bureau of Mines tests during the year indicated that electrolytic manganese from low grade domestic ores can be substituted for some uses of ferro-manganese made from high grade foreign ores.

A contract which went into effect during the year provides for the production in Minnesota of about 2,600,000 long tons of manganese concentrates from low grade ores over six year periods beginning in 1954. Provision has been made for the construction of a new prototype plant which will be somewhat larger than the usual pilot plant.

General Service Administration announced during the year that in the next four years the government will buy 19,000,000 long tons of dry manganese concentrates. Program was started to promote exploration and development of mines.

A demonstration plant to recover manganese from steel plant slag has been set up at Pittston, Pa. by a newly organized firm called Mangaslag, Inc. of Fort Worth, Tex.

Industry's primary aluminum output in 1952 in the United States was about 935,000 tons, or about 100,000 tons greater than in 1951, and greater than the record 920,000 tons in 1943. In 1952 Alcoa began production of primary aluminum at two new locations. The first half of Wenatchee, Wash. plant is now producing metal and the remainder is practically complete. Production also started at Rockdale, Tex., where lignite will eventually be used as fuel to generate the electric power. Each of these projects will have a capacity of about 85,000 tons of aluminum annually. Alcoa's Point Comfort, Tex. plant put in operation 35,000 tons of initial capacity. Production of aluminum also started in 1952 at Kaiser's Chalmette, La., plant.

Alcoa's new plant at Skagway, Alaska will take about four years to complete and will initially be capable of producing 200,000 tons of aluminum annually and will cost about $400,000,000. It will require a 1,600,000-hp water power development. Plans are being made so that production can be doubled to 400,000 tons.

With the big increase in productive capacity, it is estimated that 1,250,000 tons will be produced in 1953 and 1,500,000 tons in 1954, when capacity will be about 1,750,000 tons. With imports from Canada, this will give an available supply of 2,375,000 tons.

Expansion goal for aluminum sheet and aluminum sheet and plate heat treating facilities will provide for additional rolling capacity of 342,000 tons of aluminum sheet annually by January 1955, and additional heat treating capacity for 423,000 tons of sheet and plate on the same date. This will increase aluminum sheet, plate and foil capacity from 954,000 tons in 1950 to 1,296,000 tons in 1955.

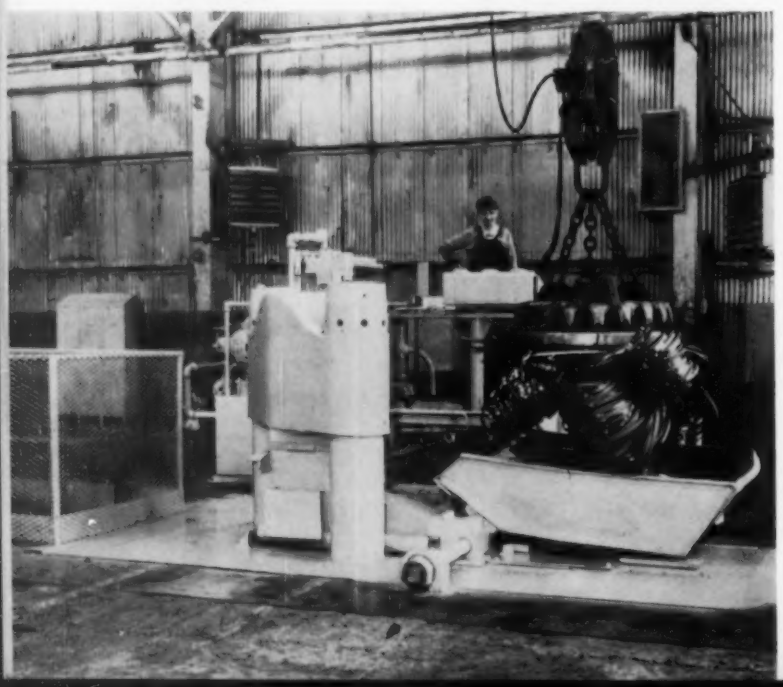
The Aluminum Co. of Canada has also under construction a large project in Kitimat, British Columbia. This unit is scheduled to start operating in 1954 at a rate of about 90,000 tons annually. Upon completion of the final stages capacity will go up to 500,000 tons.

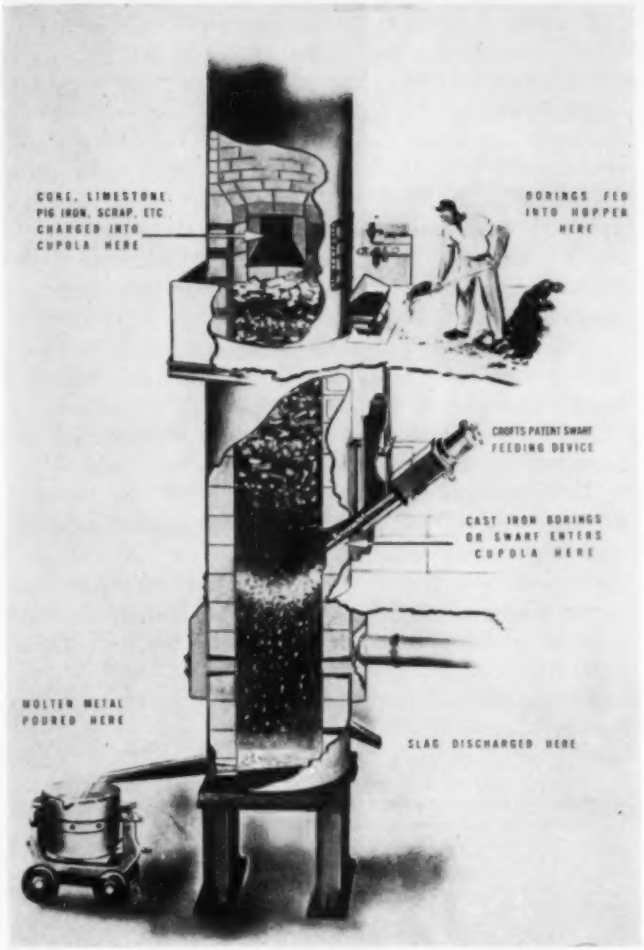
A new producer entering the aluminum picture is the Olin Industries. In the present set up they will produce about 7 per cent, Alcoa 36.8 per cent, Reynolds 26.6 per cent, Kaiser 26.2 per cent, and Anaconda-Harvey 3.5 per cent.

In 1952, the free world output of nickel was about 157,000 tons compared with 147,000 tons in 1951. Canadian production was about 140,000 tons or about 90 per cent of the total. Free world production is estimated at about five times that of the rest of the world.

Among the principal undertakings in nickel development are the Falconbridge Nickel Mines, Ltd. in

Bales of scrap produced by this automatic baler are more uniform and have greater density than heretofore possible.




CORE, LIMESTONE, PIG IRON, SCRAP, ETC. CHARGED INTO CUPOLA HERE
BORINGS FED INTO HOPPER HERE
CROFTS PATENT SWART FEEDING DEVICE
CAST IRON BORINGS OR SWART ENTERS CUPOLA HERE
MOLTEN METAL POURED HERE
SLAG DISCHARGED HERE

Schematic illustration shows a new patented method for feeding borings into cupola.

Northern Ontario, which are engaged in an expansion program to yield an annual capacity of 17,500 tons in 1954, the Nicaro Nickel project in Cuba, which is now in operation and reaching its goal of 15,000 tons annually, The Sherritt Gordon Mines, Ltd., Manitoba, which will have a capacity of 8500 tons by the end of 1953, and the French firm S. A. Le Nickel in New Caledonia which is said to be now producing about 7000 tons.

Nevertheless the DPA announced an increase in expansion goal which should provide a total annual supply of 190,000 tons by 1955. This is an increase of 58,000 tons over the expansion goal of 132,000 tons by 1954, a target which had been announced early in the year. Available supply of nickel to the United States in 1950 was 101,000 short tons. Total consumption in the United States in 1951 exclusive of exports was 86,460 short tons. The chief source of nickel imports in 1951 was Canada with 88,000 short tons. In 1952, domestic production accounted for only 62 short tons.

The supply of copper eased somewhat during the year. Production in 1952 totalled 1,250,000 tons. One of the factors in this has been the development of new ore supplies. In one case, the government allocated a $100,000,000 loan to a company who will produce over 10,000,000 tons of lean ore a year having a copper content of 0.72 per cent.

Southern Nevada Anaconda Copper Mining Co. is opening up a new pit at a cost of $38,000,000. This operation is only one of eight new copper mining projects underway or planned in the United States. These new United States mines will increase domestic output by about 200,000 tons a year or 20 per cent over 1951. The new mines will actually produce 300,000 tons, but other mines which will be shut down will reduce the net gain. In the upper peninsula of Michigan, some of the old copper mines which have been abandoned for some time are being reopened.

As an example of the easing in the copper market, Chile which had been getting high premium world prices for copper, on 20 per cent of its production was ready to renounce this agreement since the world demand was not absorbing this allocation of their production.

Six government owned magnesium plants were reactivated during the year in response to the high demand for the supply of this material. However, there was a shortage of thin gage sheets because of inadequate rolling mill facilities. A large magnesium fabricator in Detroit built and put into operation an 84-in., 3-stand mill. Other new mills in operation consist of an 84-in. continuous coiling mill at Madison, Ill., and a 66-in. hand mill.

The supply of sulphur eased during the year and about 900,000 long tons of sulphur per year of new productive capacity was put into operation. This tonnage represents 28 projects in eight nations, and of this, about 700,000 tons will come from the United States.

A relatively unused group of materials more commonly known as "rare earths" are finding increasing use in the steel industry, and may well become important in the future. A factor is the recent discovery of large domestic resources in several western states. The biggest potential market will be as additions in steelmaking where small quantities will improve the quality of the end products. One of these, cerium, is also important in the manufacture of ductile iron.

For the first time in centuries metals refining has developed a new process. Old ore refining methods depend on two extraction methods, electrolysis and smelting. This new method is primarily an acidic method. Already planning to use it is a $5,000,000 refinery now under construction which will open in the middle of 1953 at Fredericktown, Mo. It will produce annually 700 tons of cobalt, 900 tons of nickel, 700 tons of copper plus about 7500 tons of ammonium sulphate. One of the advantages of the method is that the metal comes out in a pure powdered form which is easier to handle than castings, and the requirements for electric power or fuel are not as high.

Other plants are also under way which will use the process, and the new Sherritt Gordon Mines, Ltd. in Canada which will produce nickel is being built with this process in mind. One of the advantages of the process is that the plant can be easily set up next to the mine.

Another important chemical process was revealed during the year. This is a hydrogenation process which essentially consists of taking coal, heating it under very high pressures in the presence of hydrogen and distilling off the resulting liquids from which a number of synthetic chemicals can be obtained. It is also somewhat similar to the process from which synthetic liquid fuels have been formed, under development by many companies. The basic process was used in Germany during

the war to make synthetic gasoline and much experimentation has been going on in this country on the same subject. However, the new process is a radical improvement on the old process, with advantages in that the investment is only half that of the old process and it is continuous rather than intermittent. One of the operational differences is that in the old process, coal spends 45 minutes in the reactor and in this process it spends less than 4½ minutes.

The sponsor believes the process will open a whole new coal-chemical industry. This may be of importance to the steel industry, because the process can extract chemicals from coal that cannot be had from the usual by-product coke ovens operated by the steel industry.

BLAST FURNACE

The United States produced 62,000,000 net tons of pig iron in 1952. Second was Russia with 27,500,000 net tons, third West Germany with 14,104,000 net tons, fourth, United Kingdom with 12,070,000 net tons, and fifth was France with 10,678,000 net tons.

Eight new blast furnaces were brought into operation in this country in 1952. Blast furnace capacity went up 5,597,900 ton in 1952 to 79,380,240 net ton official rated capacity on January 1, 1953. An additional 2,800,000 tons is scheduled for 1953, and another 900,000 tons in 1954.

The ten furnaces scheduled for the first half of 1953 will have a combined capacity of about 3,650,000 tons of pig iron. However, three or four of these furnaces will replace older units.

The blast furnaces which were put in operation in 1952 are the Jones & Laughlin Steel furnace at Cleveland; a Republic Steel furnace at Cleveland, the Great Lakes furnace at Detroit, the Bethlehem Steel furnace at Lackawanna, and the Weirton Steel furnace at Weirton. Lit in December were, a 570,000 ton unit at the Fairless works, a 300,000-ton unit on Neville Island for the Pittsburgh Coke and Chemical Co., and a 360,000-ton, 25-ft hearth diam unit for Crucible Steel at Midland.

The No. 2 blast furnace at the Cleveland works division of the Jones & Laughlin Steel Corp. is illustrative of a trend to automatic blast furnaces. It is so set up that one man can completely control all phases of charging. Design incorporates a stock line recorder, an automatic mechanism which does not permit the large bell to be opened until small bell is closed, a revolving hopper which distributes the charge evenly at six points around the furnace, automatic delivery of coke from the storage bins plus weighing. The automatic filling sequence is based on a pre-set cycle and as each sequence is completed, it automatically unlocks the next. At the present time this furnace uses a sequence of six skip loads of raw material, ore limestone, coke, ore coke, and coke. The operator cannot feed the raw materials until the cycle calls for them, and he cannot alter the sequence.

Also illustrative of the trend, Crucible Steel Co. of America's furnace has been set up as a completely automatic unit except for tapping.

Republic Steel Corp. increased blast furnace capacity at Warren during the year when they reconstructed their furnace, increasing the hearth diam from 27 to 28 ft.

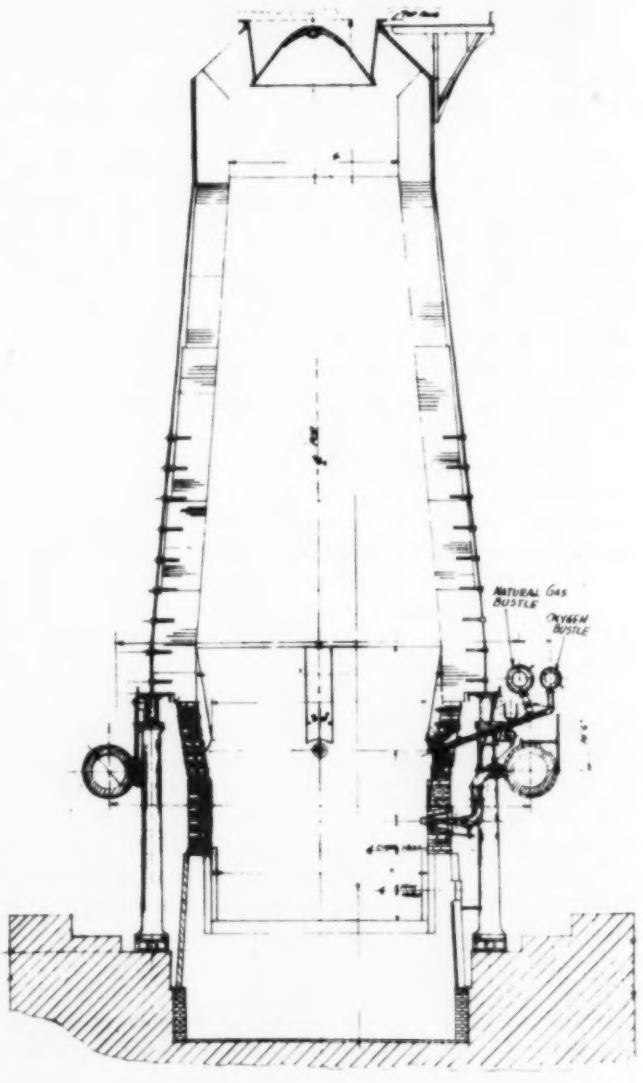
Pittsburgh Coke and Chemical Co.'s new $8,000,000 blast furnace has a hearth diam of 22 ft. With an annual capacity of 300,000 tons it will bring this company's capacity of pig iron to 800,000 tons.

Ten furnaces are scheduled for 1953. These include three for Bethlehem Steel, one at the Fairless works, one for Youngstown Sheet and Tube, one for Armco Steel, one for Portsmouth Steel, two for Interlake Iron and one for Kaiser Steel. A furnace for the American Steel & Wire division of U. S. Steel will probably not be in operation before 1954.

A technical report issued by United States Economic Commission for Europe states that blast furnaces have hardly changed in the last 100 years. Professor Robert Durrer, one of Europe's top experts contends that blast furnaces should be designed to use almost any type of fuel. Petroleum and natural gas would be two such alternatives. He also advocates a low shaft plus oxygen enrichment for combustion. One of the advantages of the low shaft furnace is that it would widen the limits of raw materials which could be used. If high grade ores become scarce it may be necessary to go to the low shaft furnace.

Two small low shaft smelters have gone into operation in Mysore, India.

Sketch shows modifications required on a furnace in order to use reformed natural gas.



In West Germany, a pilot plant which uses a new briquetting process which requires no coking coal has been called a success. In the process, dried iron ore and coke are processed, ground, mixed and briquetted. These are then charged into a low furnace with limestone and melted down with a hot blast. Main advantages, of course, are that no coke ovens are required, nor blowers, nor hot blast stoves. The plant does require pulverizing and briquetting facilities.

A new kink in the operation of blast furnaces which was suggested during the year in order to overcome high sulphur ores is to inject aluminum chips or pellets into the slag through hot air blowers near the bottom of the blast furnace. With this procedure it is expected that pig iron sulphur levels will be markedly reduced. One large company is expected to try this in the near future.

One engineer advocates the injection of oxygen-reformed natural gas and fuel oil into the blast furnace. With the use of existing blast furnace equipment plus minor equipment, and an oxygen plant, a radical change in operation can be attained which will double output of existing blast furnace units and decrease coke rates to about one-half present values.

There was no further progress on the use of oxygen in the blast furnace. The work that has been done has indicated that high temperature blast can be secured more cheaply than high oxygen blast. Therefore, with the exception of the ferromanganese furnace, which operates at high temperatures now, little consideration is being given to the use of blast furnace oxygen.

Operation of blast furnaces under high top pressures has become a standard procedure in many plants. An advantage now showing up is that production of iron from such furnaces declines less as the furnace gets old than in ordinary practice. Production of ordinary furnaces declines on the average 20 per cent after 2,000,000 tons are on the lining, whereas with high top pressure furnaces, this decline amounts to only 8 per cent.

About eleven high top pressure furnaces are in operation at the present time. In addition, it is believed that there are six Russian furnaces under high pressure operation. The Russian furnaces have shown a 20 per cent increase in production with an 11 per cent decrease in coke requirements, and a 22 per cent decrease in flue dust.

Of the high top pressure furnaces now in operation, Republic has eight, Great Lakes Steel Corp. one, Youngstown Sheet & Tube Co. one, Wisconsin Steel Co. one, United States Steel Co has one equipped, but is not using it ordinarily for high pressure operation. There are also two such furnaces in Great Britain, as well as the six in Russia.

Washing of blast furnace gas is finding increased use and every effort is now made to minimize any transfer to the atmosphere of materials from blast furnaces. One unit that went into operation during the year was at the Donora Works of American Steel and Wire division. Here a very elaborate gas washing installation was installed which reduces pollution to practically nothing.

On the new blast furnace which is being built for Weirton Steel Corp., five electric precipitators will be used. Two of these will be used to clean the blast furnace gas for subsequent use in underfired coke ovens and will have a capacity of 30,000 cfm with an efficiency of 98.7 per cent. Another will clean blast furnace gas for steam generating and will handle 55,000 cfm at efficiencies up to 91 per cent. The other two precipitators will clean gases for use in the stoves which will handle 90,000 cfm at 95 per cent collection efficiency.

Tapping side of new 20-ft top charge electric furnace at Timken Roller Bearing Co. shows inductive stirrer under bottom plate.

A blast furnace is being constructed which will have carbon block lining in the shaft zone area which is not insulated from the outside shell plates. Shower cooling is also used instead of cooler plates in this zone.

A new technique to reduce relining time of blast furnaces was used by Tennessee Coal & Iron division, where the job was done in fifty days. In this particular relining, after the temperatures had dropped in the furnace, the fire was put out with water. The fire hoses also washed the stock from the furnace instead of breaking it out by hand, saving some further time.

During the year TCI received test shipments of ore from the Great Lakes for use in their blast furnaces. These ores are being blended with Birmingham district ores to raise output in the furnaces. When Venezuelan ores are available they will probably replace the Lake Superior ores.

STEELMAKING

Steel production capacity increased 8,959,800 tons in 1952, largest gain ever, to a new high of 117,547,470 ingot net tons. With present plans, capacity will increase an additional 4,000,000 tons in 1953; 1,000,000 tons in 1954, and 500,000 tons in 1955. This will give a total capacity of 123,000,000 tons or sufficient to sustain a rate of 120,000,000 tons.

Research being done at the Massachusetts Institute of Technology for the Office of Naval Research points

to ways which may offer better steel in the future. The porosity and brittleness which is produced in steel by hydrogen may be minimized by analytical technique which gives a good picture of the hydrogen content in steel. In a second investigation the various ways in which hydrogen content affects the mechanical properties is being investigated.

Use of rare earths is a new development in steel chemistry which is becoming a more and more important factor. These rare earths have strong attraction for non-metallic elements such as oxygen, carbon, nitrogen and sulphur. Thus, they can be very useful in controlling a heat. However, more information is needed for accurately determining quantities and reactions between rare earths and other elements. So far the uses are primarily in alloy, stainless, high temperature, high speed, and electric steels. In addition to better control of impurities and gases, they increase resistance to oxidation and corrosion at high temperatures, and give easier workability (both hot and cold), and improved physical properties.

One of the applications consists of a misch metal containing about 30 per cent lanthanum, 45 to 50 per cent of cerium, and 20 per cent of didymium as well as some yttrium. This is applied in amounts from ¾ to 6 lb per ton of steel as a ladle addition in stainless, tool steel, alloy and electrical steel grades. The material acts as a strong desulphurizer and may also be very beneficial as far as the nitrogen content is concerned.

The increasing sulphur content in iron adds to the problems of the steelmaker. Much of this increase is apparently due to the use of high sulphur fuels. One method which has been tried in Sweden uses a rotary furnace in which molten metal is vigorously agitated with predetermined quantities of coke and powdered burnt lime. Heating plus the agitation gives positive control over the cycle. Excellent results are reported and the process appears to be practical economically. Claims of sulphur reduction of from 0.2 per cent to less than 0.01 per cent in from 20–30 minutes have been attained using 2 per cent lime and 1 per cent coke breeze. The use of alkalies with cast iron is effective and soda ash and caustic soda have both been used. Unfortunately both these materials are very active chemically and are volatile at molten iron temperatures. The use of calcium carbide is also effective. Its per ton cost is somewhat higher than with soda ash, but it has several advantages including freedom from obnoxious fumes and corrosive attack.

Work going on in Austria at Linz has shown that by blowing pure oxygen down on a bath of iron in a converter-like vessel, a steel can be produced which is in no way inferior to open hearth steel and is even better in many essential properties. However, the design of the tuyere, vessel shape, dimensions of bath and depth of bath, as well as the rate of applying oxygen, must be properly coordinated if good results are to be obtained. The pig iron can be refined with oxygen so that the blown metal needs no deoxidizing additions. When steel is thus refined by oxygen, up to 30 per cent scrap can be charged.

In this country one company used 24.7 per cent oxygen during the silicon blow for 3–4 min. Blowing time for this bessemer is decreased 30 per cent, tonnage of metal per minute is increased 40 per cent, and scrap melting capacity is increased from 12 per cent on air to 20 per cent with an enriched blast. In spite of these promising results, bessemer capacity was reduced during the year in the United States. At the beginning of the year, bessemer steelmaking capacity was 5,381,000 tons. About 330,000 tons of this were eliminated when the two converters of Youngstown Sheet & Tube Co. at East Chicago, Ind. were abandoned.

Steels which used to be produced in the bessemer are now being produced in the open hearth, and the AISI has recognized this in assigning grade numbers to such equivalent steels. Thus C-1211 corresponds to B-1211, C-1212 to B-1212, etc. These steels are made to have the required characteristics by rephosphorizing, resulphurizing and renitrogenizing.

The trend toward the production of grain oriented silicon steel increased this year when about 150,000 tons were made. Twice this is expected in 1953.

The increase in production of boron and alloy steel rose very rapidly this year. In the first nine months the output of steel was 507,358 net tons, which exceeded 1951's total production of 354,495 tons. Boron steel jumped to 9.2 per cent of the total alloy steel other than stainless which was produced, compared with 4 per cent in 1951 and practically nothing prior to 1951. About 90 per cent of the boron steel is made in open hearth furnaces and the remainder in electric furnaces.

An essential in the increase of the use of boron steels has been that of a new spectrochemical excitation unit which is used in analysis. Because the very minute percentages of boron in producing steel falls in the range of 0.0005 to 0.005 per cent, unusually accurate methods are required to control and see that the correct quantity of boron is used.

Quality control is finding increasing use in steelmaking technology. Very slight variations which at first may appear insignificant have a very important effect. As reported by one operator during the year, at a plant which had a slight variation in the average silicon content, it was found that 40 per cent of the heats from one furnace were below the desired minimum on silicon, but only 15 per cent from the other furnace. With a change in deoxidation practice, the yield of slabs from ingots was increased 2.7 per cent.

At the new Fairless works of the U. S. Steel Corp., all nine open hearth furnaces are being equipped with twin electrostatic precipitators. Smoke will be practically eliminated. The use of a twin arrangement makes it possible to bypass one of a pair for maintenance. Over 95 per cent of the dust normally carried in the open hearth exhaust is expected to be eliminated.

A large number of zebra roofs were in operation during the year. Operating experience indicate that this type roof increases steel production. Thirteen plants which operate 147 furnaces reported increased production of from 2 to 10 per cent.

A special zebra construction was also developed for the zone of greatest wear when this extends more than 7 ft out from the skews. In this design, the stronger silica key wedges are used to support the basic key wedges, which have a relatively low hot strength. In this way it is possible to safely extend zebra construction from skew to skew.

Increased production is also being obtained from rammed open hearth bottoms. This construction was

used in the new Jones & Laughlin Steel plant in Pittsburgh. Since burning in a bottom requires from 8 to 10 days and a rammed hearth five days, there is a time saving of 3 to 5 days in getting each furnace into production. It is also claimed that furnace refractory life in the roof, sidewalls, etc., is extended about 8 per cent.

The use of castable refractories or refractory concretes is also increasing due somewhat to the shortage of skilled masons and to the reduction in inventory of special shapes, elimination of expensive cutting and fitting of brick work which can be obtained plus a savings in time and cost of installation.

A new high pressure jet technique has been developed for cleaning open hearth checker work. This consists of forcing chemical solvents under high pressures through specially designed nozzles. Pressures as high as 3000 psi have been maintained. This technique has two effects on the deposit. First, the mechanical action of the solvent hitting it under high pressure serves to loosen the material, and secondly, the solvent reacts with the deposit dissolving the scale. These two things make this a very effective cleaning operation. The job can be done quite quickly. As an example, a furnace in a large eastern steel plant which was badly clogged with flue dust was cleaned in ten hours with about 85 per cent of the dirt removed from the four checker chambers.

An indication of the trend to electric furnaces is the conversion by Timken Roller Bearing Co. at Canton, Ohio, completely to electric furnaces. The three 125-ton open hearth furnaces have been replaced with three modern 20-ft, 80-ton top charge, basic electric arc furnaces. The last open hearth went out of operation on December 1 and this company now is melting all steel in electric furnaces. The unique feature of this plant is that an induction stirrer is in operation on one of the electric furnaces. This is installed on the first unit to go into operation. The first weeks of operations on this stirrer indicate that results will be very gratifying. Trends at the present time indicate final sulphur as about 25 per cent lower than conventional furnaces. Control of carbon and final product is very accurate. Other elements are held within narrow ranges. Much delay in the slagging operation has been removed and this is also more thorough. Slagmaking during the finishing period is more rapid and can be accomplished with less effort. Better homogeneity of the bath is reached in a much shorter period of time, and temperature measurements are much more indicative of the overall temperature.

Electric furnaces are becoming large enough to produce as much as the larger open hearths. The latest large unit is 24-ft in diameter, and has a 30,000 kva transformer. This furnace can melt 100 tons of cold charge, and compete tonnagewise with 200-ton open hearths using 50 per cent hot metal charges.

The development of self-baking electrodes should spur development of bigger and better electric furnaces, as has happened in Europe where the use of self-baking electrodes free the designer from the usual shape and length limits. This will result in larger smelting furnaces, and in other than the conventional arrangements of electrodes. Claims are also made that electrode consumption is less and cleaner operation is present. The largest furnace so far built is the 30,000-kw open carbide furnace in Germany, which has three electrodes each 1.5 meters diameter.

Cost and improvements in stainless steel melting practice are being made. Most of these are minor but they total up to better and more economical stainless. Included in these practices are the use of nickel oxide sinter, chromium pellets, oxygen, and electrolytic manganese. In the handling of scrap, developments have been made in spark testing so this has become the most practical method within some plants for the identification by grade of large and medium scrap pieces.

A number of coal producers and utility companies have joined together in a research project which will try to make steel directly from iron ore without the blast furnace step. Experiments are being carried out in an electric furnace, where high grade concentrates which are now being produced from low grade iron ore indicate that such steel can be produced directly.

The possibilities of using electric furnaces to convert ore into iron without the use of scrap will be the foundation of the operation of a steel plant of a South American country. Two such electric smelting furnaces were ordered for this plant. There are some 25 such installations in Europe, but they have never before been used in South America. These units will produce 200 tons per day and are rated at 18,750 kva. In the furnaces, six carbon electrodes are arranged in line which permit the electrodes to be spaced to suit varying ore conditions. Their use is economical where coke is scarce.

As part of the development of integrated iron and steel plant in the Union of South Africa, the Dominion Iron and Steel Corp., Ltd. of Johannesburg started a program to raise capital to build a plant using the Krupp-Renn reduction process. Actual production is scheduled for late 1953. Iron output is anticipated at 70,000 tons which will be converted to steel output of 48,000 tons. Good coking coal is not available at this location. Charge for rotary furnace will be 4300 lb iron ore (48 per cent Fe), 2000 lb duff coal, and 200 lb limestone. Product from Krupp-Renn plant will be converted into pig iron in Thomas furnaces. Steel will be produced in two 10-ton bessemer converters.

Tests made during the year indicate the commercial feasibility for the production of iron, which is practically all better than 99.5 per cent pure. This iron has been produced in a six-ton basic lined electric arc furnace.

Rammed fantail and fantail noses offer interesting applications for monolithic refractories.

Another new development during the year in direct reduction field was announced by the Ontario Research Foundation. This group has developed a process which will produce useful articles directly from the iron ore. In the process, a fine prepared ore or even a mill scale is reduced with coke and limestone in a continuous kiln. Both plain carbon, and carbon and alloy steel can be obtained. Slabs, bars, pipes and other shapes have been produced which have densities of 64 to 450 lb per cu ft. The variation is obtained because of the fact that some ores swell during the reduction process and others shrink. By selecting the correct proportion of various ores, predetermined final densities can be obtained. This can be modified by also adjusting the screen size distribution of the ground ore to vary the amount of voids in the final product. Other factors in the variation are the amount of reduction, and treatment at higher temperatures or longer times.

Pipe has been made by moving a mold through the kiln very rapidly and shaking out the unreduced ore which is in the center.

A number of corporations have asked for licenses to operate the unique process.

Reduction is carried out at a temperature of about 2000 F, and the material is also held for a longer treatment time of several hours at this temperature. The variation in density is due to the spherical voids which are not interconnected. This enables relatively easy heating and hot working without worrying about excessive oxidation and scaling.

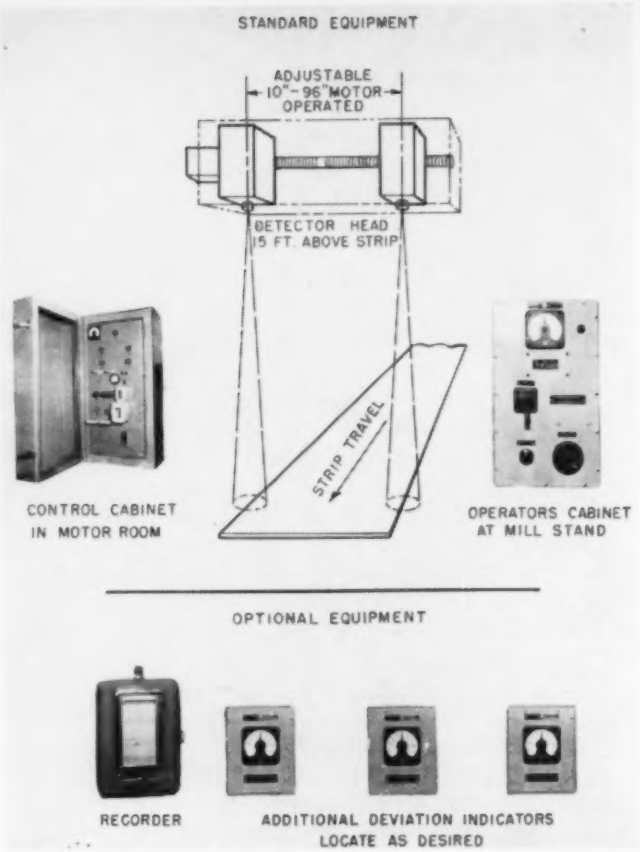
Pouring of steel into ingots has been made easier at one steel plant which is using a mechanical method. In the operation of this equipment, hydraulic power is transmitted to a stopper rod slide so that movement of the stopper rod can be controlled by an electrically energized push button box which is carried by the steel pourer. The pourer thus has fingertip control of pouring operation regardless of the size of the heat. The equipment also improved OK pour ingots in the open hearth shop in this plant with an average jump from 83 per cent up to 93 per cent after the installation.

The very large and unusual requirements for large ingots has required one operator to cast ingots which weigh as much as 722,000 lb. These are used primarily in huge aircraft presses.

The use of oxygen and natural gas hot top heating has increased the yield of special steels. With this heating, the volume of the hot top can be reduced to one-half of its former size, and most of the hot tops solidify to sound metal with or without the usual shrinkage cavity typical of the regular hot top ingot. Batteries of oxy-natural gas burners heat the top of the ingot after the metal has been poured. No water cooling of the burners is necessary. Increased ingot yields of about 10 per cent have been claimed. A number of steel producers are testing the process, and some of these are using them on ingots up to 21-in. square. Each ingot has its own burner.

A mold wash which was developed has the good qualities of tar and pitch, but does not have the fumes normally present during coating and pouring. This material consists of 4.0 parts water, 1.4 parts of graphite type 296, 1.0 part of masonoid, 0.6 parts of pitch, and very minor fraction of anti-foam and wetting agents.

A new and completely automatic scrap bailer was



Schematic diagram of width gage for continuous hot strip mills.

installed at Wheeling Steel Corp.'s Beachbottom works. This new bailer produces bales of scrap that are more uniform in size and weight and greater density than before possible. The new unit compresses steel scrap to a density from 45 to 70 per cent depending on the type of scrap on hand. This compares with the average 14 to 30 per cent with existing equipment. Unit is completely automatic and three hydraulically operated rams developing 225,400, and 750 tons of pressure compact the scrap into easily handled blocks.

The Association of Iron and Steel Engineers issued during the year a set of specifications for the design of hot metal ladles (AISE Standard No. 9). This specification is based on a great deal of research work financed by the AISE and should result in better ladles. The specification has been summarized into relatively simple design formulae.

Steady progress has been made in continuous casting, and a commercial stainless plant may be started by the end of 1953. Up to now squares 7 × 7 in. and 9 × 4¼ in. ovals have been cast successfully. These sizes are also being followed by 6 × 6 in. squares which are designed specifically for stainless steels for extrusion.

In an experimental run of approximately 700 tons of A-83 carbon steel, a number of conclusions were reached and one of the outstanding results was the very high percentage of usable tube rounds which can be obtained by continuous casting from a given weight of liquid metal. An electric furnace shop would give a yield of about 90 per cent for continuous casting, compared to ordinary ingot practice yield of about 70 per cent. When casting such items as stainless, this is a difference in yield which becomes very important.

The first commercial installation of a new type continuous casting machine was announced during the year. Atlas Steels, Ltd., of Welland, Ontario, Canada ordered a continuous ferrous metal casting machine for the production of tube, stainless and other high grade steels. It is expected that this unit will yield from 10 to 15 per cent more finished steel per heat than conventional pouring methods. The unit will have a 100 sq in. cross-section and is expected to be in operation in the fall of 1953. The machine will produce 4¼ × 4¼ in. billets, 5½ × 7½ in. billets and 5½ × 21½ in. slabs. Speed will vary up to 100 in. per minute.

At a west coast plant aluminum bar is continuously cast in a 1 × 7 in. section. This in turn is cut to 55 ft lengths which are hot rolled into strip for venetian blinds without any edge trimming. In the equipment, casting speeds vary from 4 to 15 fpm depending on the alloy and material in the bar. The machine has been designed to operate on a continuous basis and an adequate reservoir must be provided. Melting is done by two low frequency induction furnaces.

ROLLING MILLS

The year 1952 was a year for installing or putting into operation the large number of mills required to form the additional ingot capacity going into operation. Even so, rolling mill manufacturers are working at capacity to build the units still on order. Most of the new mills include refinements in design, higher speeds, greater power.

An interesting rolling mill development is the trend by warehouses to add rolling facilities. In most cases, these consist of a single stand 4-high reversing mill. By the use of such mills, these warehouses are able to supply customers with small lots of cold rolled strip in various widths, gage, tempers and finishes, and consequently are able to reduce their stock sizes. The mills, in general, are designed to permit heavy reductions in each pass, and to operate at speeds up to 1000 fpm.

As mentioned in the 1951 development report, rolling mills are being built in packaged units. A new development this year is in the power supplies for such mills, which are also built in packaged units. One unit has, for example, a metal cabinet about 6 × 8 × 3 ft which houses all the control apparatus, a 75-hp motor-generator set and a small booster generator set to provide IR-drop compensation for the reel motor and to improve regulation. A selenium rectifier is used for the excitation, thus eliminating one rotating machine.

Rolling mill speeds of 9000 fpm are receiving some consideration on the part of the industry. However, there is some trouble with present mills designed for 2/3 that speed, and which are therefore normally run at less than 5000 fpm. Some of the problems are lubrication waves, tears, chatter and that of maintaining roll contact.

An extensive program under way in England to determine the various ways in which mill speed influences rolling load and strip thickness, brought out the fact that variations in the coefficient of friction between rolls and strip is the principal cause for load and thickness changes. From experimental results, they developed a relationship between the mean coefficient of friction and the speed of the mill. Work was done on both steel and copper strip with entry thicknesses of between 0.050 and 0.010 in., and at mill speeds from 10 to 300 fpm. The lubricants tried were commercial rolling oil and colloidal graphite.

An interesting new rolling mill was scheduled and authorized for a large aluminum plant at Davenport, Iowa, which will go in operation in 1953. This mill is designed to produce very wide tapered sheet and plate up to 120 in. for aircraft. Machine will handle both hot and cold ingots and is reversible. The novel feature is the taper in the sheet thickness.

The Pittsburgh Steel Co.'s 66-in. tandem cold reduction mill is designed to operate with a maximum delivery speed of 3100 fpm. Steel strip from 24 to 62 in. wide and 0.015 to 0.050 in. thick will be produced. Maximum coil size is 60,000 lb. Mill will be in operation in the middle of 1953.

A Sendzimir hot strip mill was installed during the year at the Naval Ordnance Laboratory at Silver Springs, Md. This mill can reduce a 1 in. thick ingot to 0.030 in. in less than a minute.

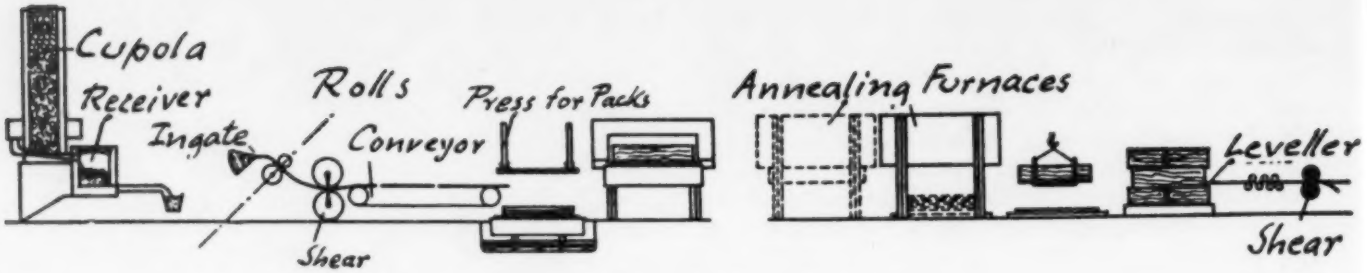
Two Sendzimir strip mills are being combined into a new installation for Atlas Steels, Ltd., Welland, Ontario. These include a 19-in. planetary hot strip mill and a cold reduction mill. Capacity for stainless is estimated at 8000 tons annually. Facilities should be in operation in 1953.

In the Atlas mill, slabs 2¼ in. thick will be rolled in one pass to ⅛ in. bands in coils of 4000 lb weight. Since heavier reductions are possible on the cold mill, intermediate annealing and descaling lines are simplified. Another similar unit which was under test in this country has been sold and shipped to Europe.

Increasing demand for very thin metal strip has led to the development of a new small Sendzimir mill which will cold roll electrical alloys to as thin as 0.0002 in. The number of passes required depends on the stock being rolled. Work rolls are 0.250 in. in diameter.

An interesting development in continuous gage control for sheet and strip rolling uses an electrical roll force measuring element, the output of which continuously adjusts either, position of the rolls or the tension applied to the strip, so that a constant thickness is maintained

Resistance to flexing is easily measured by the test recently developed by Jones & Laughlin.



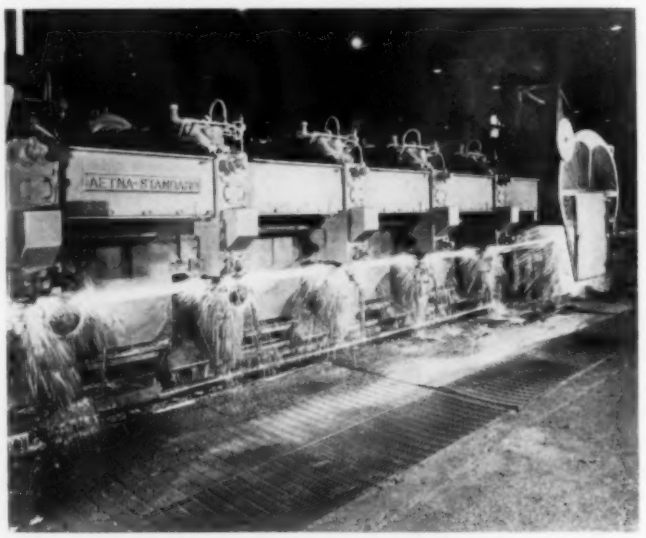
Schematic diagram of setup for rolling of cast iron.

in the rolled materials. Preliminary experiments on a small 10-in. 2-high mill have shown that these methods are correct in principle.

A steel mill width gage was introduced during the year. This is a non-contacting device which automatically measures the width of hot strip steel to an accuracy of plus or minus ⅛ in. Unit consists of a detector head, operator's cabinet and electronic cabinet. Two phototube scanners pick up light radiated from the strip which is converted into electric signals. These signals consist of two pulsating square waves which are amplified and added together and balanced against a standard voltage so that the difference produces a signal, proportional to the width deviation. Widths of 10 to 96 in. can be measured at temperatures from 1350 to 2050 F. The strip position can change as much as 3 in. vertically or horizontally without affecting the accuracy of the gage.

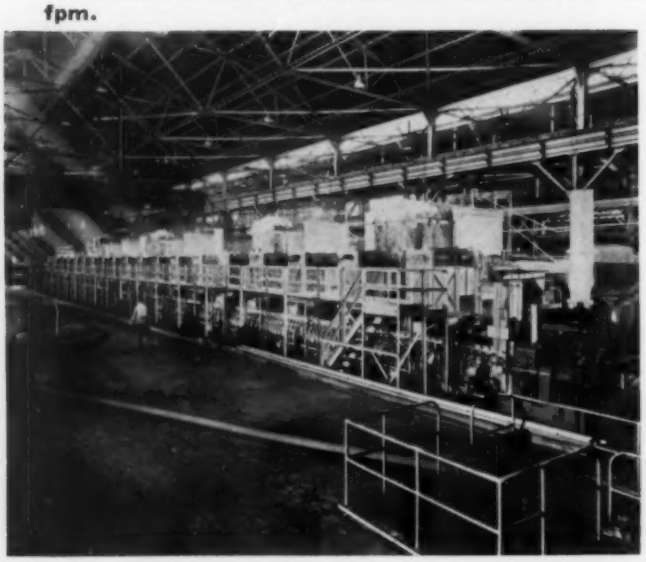
A method for checking flat product properties developed during the year is the flex-test. This is an instrument, which by measuring the resistance to bending of sheet, gives an accurate measure of the drawing quality of cold reduced sheet and strip steel. A sperometer, adapted to measuring the diameter of the bend in the sheet, makes an accurate determination of the material's susceptibility to stretch or strain during the drawing process. Test takes about a minute.

An interesting rolling development was reported from Russia on the rolling of cast iron into strip, in widths up to 41½ in. In the process, metal is tapped from a cupola, going onto a rotating water-cooled bottom roll, solidifying instantly at the surface of contact. The plane of rolling has a 45 degree slope with the vertical. The surface of the strip is then cooled by contact with a smaller top roll and at the same time is deformed under the rolling pressure. The thickness of the strip is controlled by varying the surface speed of the roll. After rolling, the sheets are annealed in a decarburizing atmosphere if necessary. When this is done, the resulting properties are the same as steel sheets of the same chemical composition. This process is being used on a production scale in the Soviet Union, and costs there are estimated as one-half that of regular steel sheet produced by conventional processes.



Wheeling Steel's new 12-stand mill consists of 12 pairs of grooved rolls arranged in six sets.

New continuous weld pipe mill at Wheeling Steel Corp.'s Benwood Works forms pipe at speeds from 450 to 1000 fpm.



One of the outstanding units put into production during the year is the 46-in. high lift blooming mill for the Jones & Laughlin Steel Corp. Details were given in last year's Development Story. One of the interesting features of this mill is that there are no hydraulic manipulators, since it is equipped and handled with electrical controls.

An interesting plate mill which is being installed in a Texas plant for a machinery manufacturer is a 160-in. unit. This mill has 160 × 59-in. backup rolls. It is driven by a 10,000-hp twin motor drive. Novel on this mill is the use of a motor on each work roll, driving it through a planetary system. In addition, as the screws raise the rolls, the motor rises along with them.

A 24-stand rod and merchant mill which is being built for Italy features very close coordination of control and motors to provide low impact drop and close speed control. Each stand is individually driven by a d-c motor

X-Ray pipe wall thickness gage shows probe tube about to emerge from inside a pipe. Paint sprayed line indicates under gage area which must be cropped off.

to permit maximum flexibility and use for the various rolling schedules. Motors driving Stands No. 3 to 24 are controlled with electronic speed regulators which operate in conjunction with field booster exciters to limit the speed dip when the new load enters the stand to a fraction of that which occurs when regulators are not used.

An interesting tube mill which went into production during the year is an 8-stand mill operating at 700 fpm which specializes on small diameter butt weld pipe. This mill was built for the purpose of making ⅛, ¼ and ⅜ in. butt weld sizes in the full range of standard, extra heavy and galvanized grades. Annual capacity of the plant is estimated at 35,000–40,000 tons annually.

The new continuous weld pipe mill at the Benwood works of the Wheeling Steel Corp. forms pipe in various sizes at speeds of from 450 to more than 1000 fpm. The unit has a completely synchronized electrical motor drive system which provides power for pulling the skelp through the heating, forming and welding equipment at a very accurately controlled speed. This 12-stand mill consists of twelve pairs of grooved rolls arranged in six sets, each with a pair of vertical and horizontal rolls.

Two new tube mills for continuous production of welded steel tubing were also installed at the Mound Road plant of Ford Motor Co. in Detroit. The first mill makes 2¾-in. outside diam tubing for drive shafts. The second mill makes 4½-in. outside diam tubing for axle tubes. At the present time these mills are producing tubing for drive shafts at the rate of 105 fpm, and axle housing tubing at 70 fpm.

Republic Steel Corp. will start production of seamless tubing at its South Chicago plant early in 1953. This mill will have an annual capacity of over 150,000 tons. A 75-ft diam rotary hearth furnace was built for this installation.

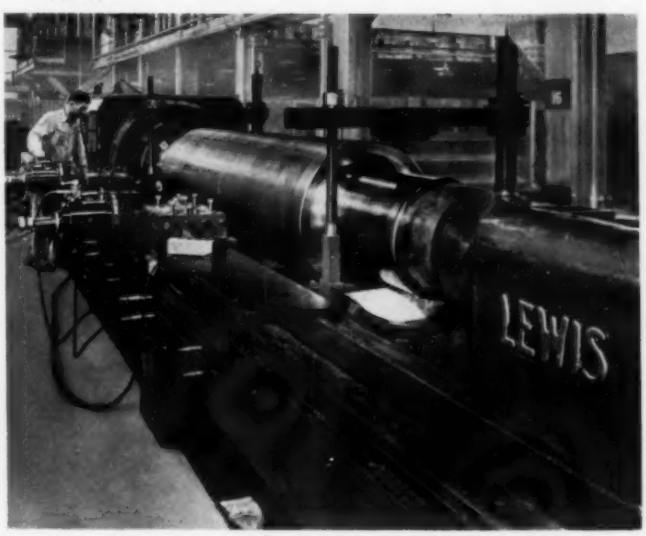
The new tube mill of Lone Star Steel Co. at Daingerfield, Tex. will be in operation sometime in the second quarter of 1953. The Colorado Fuel and Iron Corp. also plans to have its Pueblo, Colo., facilities producing before the end of the year. These three mills will add some 233,000 tons of casing and tubing to regular production during 1953 to bring planned output of tubular products in 1953 to about 1,783,000 tons.

All thicknesses of pipe ranging from 0.050 to 1.500 in. can now be determined with an accuracy of 1 per cent by an x-ray pipe wall thickness gage. This consists of an x-ray generator and pick-up tube which are mounted on a hydraulically operated carriage aligned with the rotating rolls. The x-ray beam is converted into an electrical signal which is amplified to actuate an indicating meter, and automatic servo-mechanism. Paint is sprayed on the outside of the pipe at under-gage areas. This gaging method saves material and labor.

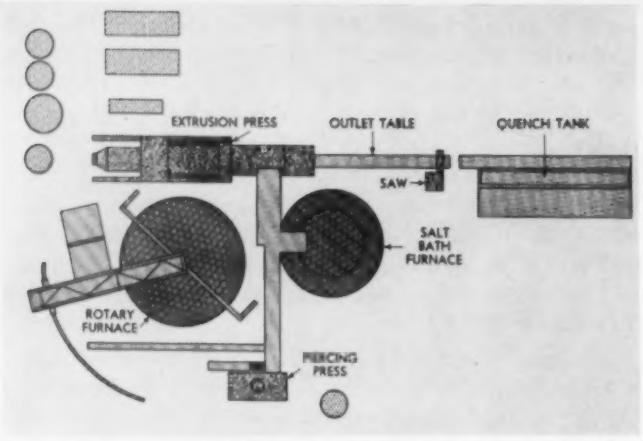
A new automatic pipe tester which was installed at the Aliquippa plant of Jones & Laughlin Steel Corp. is capable of testing 2⅜ to 7-in. outside diam pipe in lengths of sixteen to fifty feet, at average cycle speeds of about three pieces per minute. Another unit which is being installed will be able to test 5½ to 14-in. outside diameter pipe. The installation of the first unit has resulted in reduction of man power from 20 to 30 per cent. The operating sequence is electrically controlled.

Two unusual machines were recently developed, one to reduce 10-in. diam tubing, and the other for 18-in. diam tubing. The large machine consists primarily of a roll housing weighing close to 150 tons which travels back and forth horizontally for about 7 ft. This housing carries 50-in. diam rolls for which removable insert dies

New hydraulic roll lathe gives time savings up to 75 per cent.



Defects in tubing are being found through the use of induced circumferential current.



Layout shown was designed specifically for the design of solid and tubular shapes by the extrusion process.

are provided so that a complete roll change is not required for each change of pass. Equipment was developed in response to a demand by the Navy for large diameter, light wall, cold finished seamless tubing.

Steel and aluminum tubing are being resized by pulling an elongated steel ball with a length of cable through the tubing. Operation is normally used on tubing which has been flattened during bending. Several balls are used, starting first with small ones and increasing the size to that required for the final inside tube diameter. Tolerances as close as 0.001 in. are claimed.

At the Sierra Drawn Steel Corp. at Los Angeles, an 800,000-lb capacity draw bench was installed. This is the first one of its type on the west coast, which is able to cold form up to 4½-in. rounds. One, two or three bars can be drawn at a time depending on the size.

A hydraulic roll lathe was developed during the year. The first unit is being installed at the Fairless works of United States Steel Corp. This consists of a 60-in. lathe for which hydraulic pressures are used to control the infeed, lateral movement of the tool, and movement of the tail stock. The lathe also has a number of other unique features. Time savings up to 75 per cent are claimed with this new lathe.

A new line of floating worm gear motors for roller conveyors of rolling mills allows direct application of power. Unit is so designed that the shaft of a hollow worm gear is slipped over an extension of the roller shaft. Advantages are elimination of separate gear reducers and couplings with consequent less maintenance.

One of the hottest developments in the forming of metals lies in the application of extrusion to obtain shapes and materials not now available. A 2500-ton installation went into service during the year at the Babcock and Wilcox Tube Co. Several others have either made pilot tests or will do so shortly.

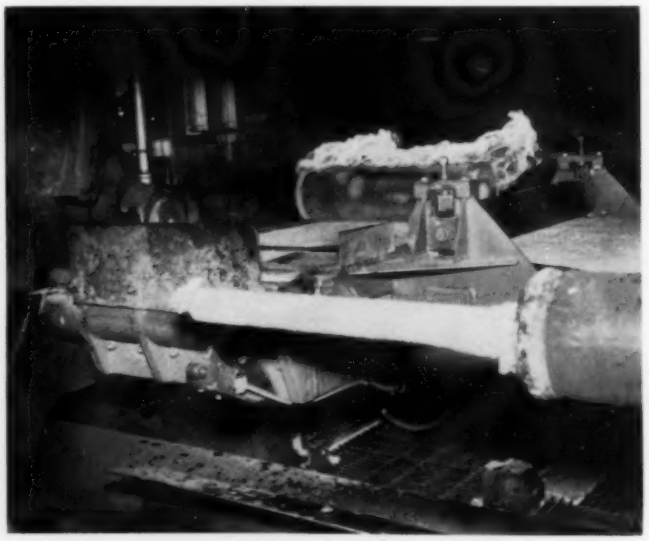
New B & W installation is using the glass stocking process. As a result of this application, extrusion ratios are increased. The process is being used at B & W for highly alloyed steels, stainless steels, and other materials such as molybdenum, vanadium, titanium and zirconium.

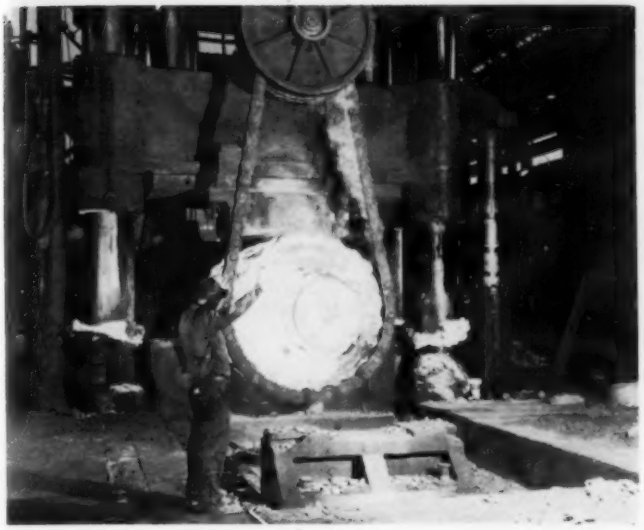
In the higher grade alloys, the tubular extrusion has an economic advantage over rotary piercing, particularly where cold reduction takes place subsequent to the production of a hot finished tube. This is because the extrusion produces a tube which is free from breaks in the surface such as may be found in rotary pierced tube. In addition it can produce lighter wall tubes thus eliminating cold passes. It can also produce high alloy tubes at a faster rate per manhour. Noteworthy at Babcock & Wilcox has been the extrusion of tube from round-cornered, square, continuously cast billets, in which finished tube has been produced from molten steel in just three operations.

Such extruded surfaces which have been produced have required almost no grinding on the outside surface, and the internal surface has been so good that no work need be done, even on requirements for redrawing. This in turn eliminates an appreciable amount of cold work. In addition, in high alloy production small orders are the rule, and it is much easier to change size on an extrusion press, since less than four minutes are required to make such changes. On the other hand, in the case of carbon steel and low alloy grades, rotary piercing can produce so many pieces per hour that it may be doubtful as to whether the extrusion method can compete economically on such items. Extrusion process can produce special cross sectional shapes which cannot be produced by the ordinary piercing process or rolling process.

One of the important developments in making extrusion process practical was the development of a formula which expresses the pressure necessary to effect the extrusion of given metal at a given temperature. This was originally established theoretically and then vertified by actual trials. The formula gives the specific pressure to be applied to a billet in relation to the extrusion ratio, the coefficient of friction and the inherent resistance of the metal to deformation at a selected temperature. As a result of these studies, families of curves have been developed which show the resistance to deformation as a function of temperature for many well known steels and other high temperature alloys. These data have been correlated with creep values for these materials. Much of this is available in nomographic charts and on a circular slide rule. As a result of these experiments, the designer can predetermine the characteristics and possibilities of extrusion

In the Ugine-Sejournet process, glass is introduced as a lubricant by placing a fiber glass sock over the piercing mandrel.





Large forgings present many production problems.

by various sized presses, and determine the ability to manufacture various designs of products.

So far five steel producers as well as one fabricator have taken out licenses to hot extrude basic steel products by the Sejournet process. Babcock & Wilcox, previously mentioned has been in commercial production on stainless alloy and carbon tubing for some time. The Gary works installation of National Tube Co. has been in operation since September. Allegheny Ludlum extruded its first tubing in November. Another unit will be installed by the Jones & Laughlin Steel Corp. at their Pittsburgh works.

The National Tube Co. is the only one which uses a mandrel to pierce a billet when making a tubing. All other companies pierce on a separate vertical hydraulic press and then extrude on a big press. All plants use a glass plug in front of the die, although with carbon tubing, it is usually not necessary to wrap the pierced billet and mandrel with glass blankets as is done with stainless. One of the outstanding features of the extrution process is the tolerance and finish which is now available.

A new process, called the coldflo process, for cold extrusion of commercial steel items up to 30 in. long and weighing fifty pounds was started at an Ohio plant. The process is effective in the production of flanged, squared, triangular or fluted shapes.

Another important development during the year has been the emphasis on the heavy press program for making large forgings. The design of some of these units involve difficult engineering and manufacturing problems which must be overcome. Huge forgings far beyond present available capacities, and pieces extremely difficult to ship, are some of the factors which are holding the program back. The Air Force has been pushing this program which now involves 17 presses. Eight of these presses are forging presses which vary from 25,000 to 50,000 tons capacity, and nine are extrusion presses from 8000 tons to 25,000 tons. A 75,000-ton forging press is also under consideration. The work has been assigned to six press contractors.

As an example of the problems, the columns or tie rods in the 50,000-ton capacity press are 110 ft long and weigh 320 tons each.

Present press program scheduled is given in Table II.

At the present time there are only three large presses in operation in the United States, one is at the Wyman-Gordon plant at North Grafton, Mass., one at the Alcoa plant in Cleveland, Ohio, and the third at the Bohn Aluminum and Brass Co., Adrian, Mich. The Wyman-Gordon plant is American made, the other two are built in Germany and reassembled in the United States.

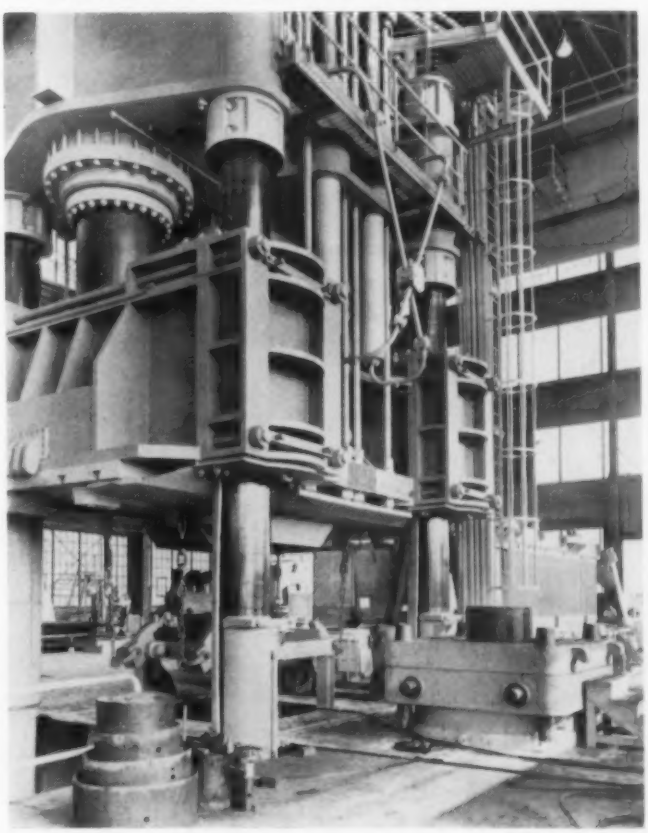
TABLE II

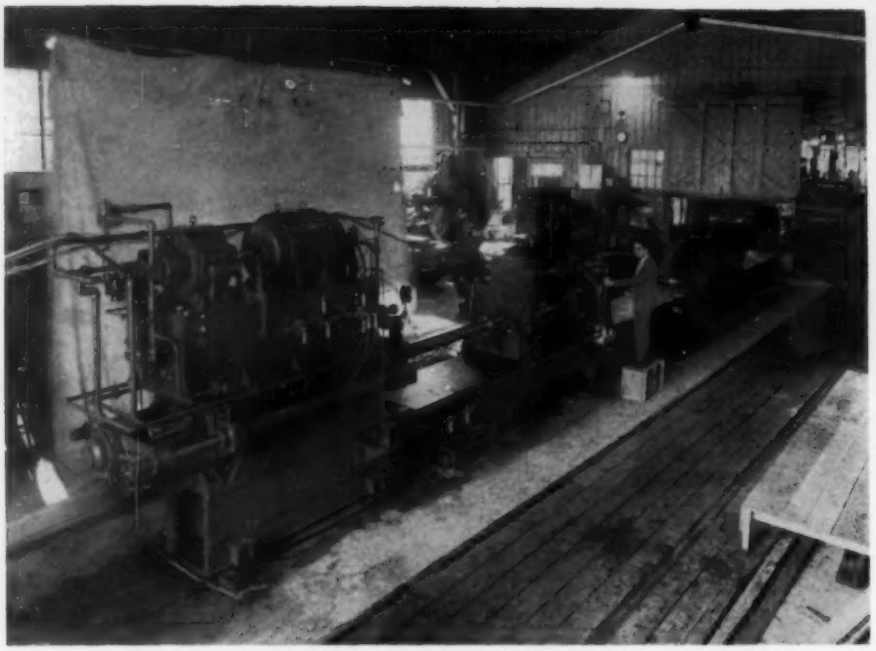
Heavy Press Program

Press size and type (Tons)	To whom and where
(1) 50,000 forging	Alcoa, Cleveland, Ohio
(1) 35,000 forging	Alcoa, Cleveland, Ohio
(1) 35,000 forging	Harvey Machine, Torrance, Calif.
(1) 20,000 extrusion	Harvey Machine, Torrance, Calif.
(1) 12,000 extrusion	Reynolds Metals, Phoenix, Ariz.
(1) 25,000 forging	Harvey Machine, Torrance, Calif.
(1) 35,000 forging	Kaiser Aluminum, Newark, Ohio
(1) 25,000 forging	Kaiser Aluminum, Newark, Ohio
(1) 50,000 forging	Wyman-Gordon, Worcester, Mass.
(1) 35,000 forging	Wyman-Gordon, Worcester, Mass.
(1) 25,000 extrusion	Bohn Aluminum, Adrian, Mich.
(1) 20,000 extrusion	Alcoa, Cleveland, Ohio
(1) 12,000 extrusion	Curtiss-Wright, Buffalo, N. Y.
(2) 8,000 extrusion	Kaiser Aluminum, Halethorpe, Md.
(1) 8,000 extrusion	Reynolds Metals, Phoenix, Ariz.
(1) 8,000 extrusion	Harvey Machine, Torrance, Calif.

A new concept in heavy press design may make more economical construction for these huge presses. A scale model of a proposed 75,000-ton throatless forging press was recently unveiled. In this design, a monolithic concrete structure is used capable of supporting and suspending a 75,000-ton hydraulic press. This requires the solution of no construction problem more difficult

This vertical press is set up for ingot piercing which is the first step in forming a hollow forging.





Hydraulic stretcher is rated at 100 tons. Combination of twisting and stretching will cure almost any kink, twist or camber in metal bars of any section within the limits of the machine's power.

than normal pre-stressed concrete technique. The development of this model leads some designers to theorize that 300,000-ton units may be built with existing machine tool and foundry capacity.

A new type of forging press was also developed during the year. This is essentially a horizontal drop forge in which both dies are moving, approaching each other at a relative speed of about 32 ft per sec. The stock is positioned in the impact plane in which two dies collide. By hitting the work piece from both sides at the same time, certain advantages are gained, one is improved grain flow. When only one die is moving, the point of zero velocity is near the center of the bottom, so all motion must center around this point, and when the piece is hit from both sides, point of relative zero velocity is at the physical center and deformation takes place around that point. With the new press, it takes about 23 per cent less energy to make a forging.

FINISHING

The world's fastest vertical acid-type electrolytic tinning line began operation at the Fontana plant of Kaiser Steel Corp. in the latter part of the year. This line, rated at 1200 fpm, will produce more than ten 2-ft long sheets of tin steel per sec. Entire process is automatic, including cleaning, pickling, plating, reflowing, oiling, shearing, classifying and piling of the tin-coated steel strip. Two control panels, each over 90 ft long, are used to regulate the a-c and d-c sections of the tinning line.

Another unique feature is the installation of a beta-ray gage in its first application on a continuous tinning line. Another improvement on the sheet classifier is a design by which different flights of the classifier can be shut down and jogged to clear up a cobble, and then reaccelerated without shutting down the line. This reduces spoilage. This tin plate mill is also designed to commercially produce differentially-coated tin plate, a development reported in last year's story.

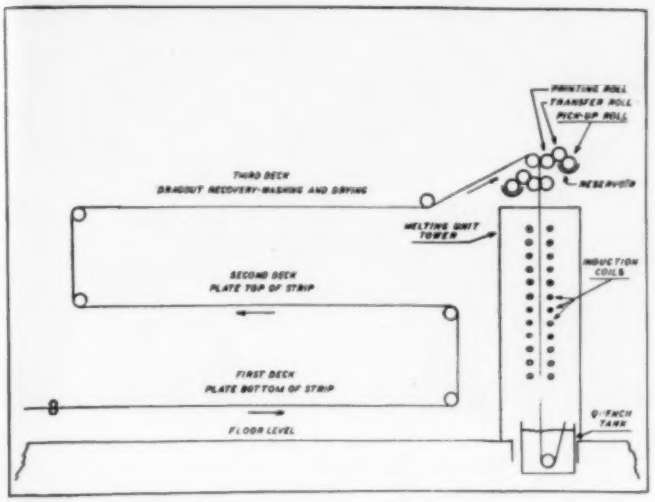
Differentially coated tinplate has found acceptance. It has also been found possible to use such electrolytic tinplate on sanitary packs where the tinplate is used alone without protective lacquer. Most of these experimental packs have been for tomato juices. In these tests, a coating weight of 1 lb is used for the interior of the can, and 0.25 lb for the exterior. This compared with hot dip product of 1.25 lb results in a reduction of about 35 per cent in tin consumption and cost savings of 30¢ per base box to the consumer. Electrolytic tinplate is still finding itself increasing its share of the market. In 1951, 2,874,851 tons of electrolytic tinplate was used compared with 1,566,199 net tons of hot dipped plate according to the AISI.

The tin finishing department of the new Fairless works of U. S. Steel will produce 170,000 tons of tin plate annually. This capacity will be produced on two tin plating facilities, a ferrostan electrolytic line, and five hot dip tin pots. The electrolytic line is the fastest ferrostan line ever constructed, and has a speed of 1200 fpm, and a rated annual capacity of 135,000 tons tin plate with coatings ranging from 0.10 to 1 lb per base box. The five hot dip tin lines, however, have a rated annual capacity of 70,000 tons of tin plate with an average coating of 1.25 lb of tin per base box.

A detinning plant was constructed during the year at one of the larger integrated steel plants to conserve every possible ounce of tin. The plant has a capacity of 300,000 lb of tin and 30,000 tons of high quality steel scrap per year. Material used comes primarily from the manufacturing operations of the tin mills. In the process, batches of about 6000 lb of scrap are put in a drum, which is lowered into a detinning tank which contains a bath of caustic solution. Drum rotates and after 2½ hr, the tin has been dissolved from the steel and gone into solution as a sodium-tin compound. The drums are then rinsed, and the steel taken to a hydraulic press where it is pressed into bundles ready for charging into the open hearth. The sodium-tin compound is pumped from the detinning tanks and processed through several processes to finally release the tin. Detinning reagent is a 50 per cent solution of sodium hydroxide with an addition of sodium nitrate which is kept at a temperature of 195 F.

The sludge settling at the bottom of high speed electrolytic lines is also processed in the tin reducing equipment and 8000 to 10,000 lb of tin are recovered every month in this operation.

Another steel plant is recovering zinc dust at an estimated savings of 6000 lb per month. Advantages of this equipment are the large size, complete mechanical handling of the dust, and use of recirculating water to recover the dust that escapes the cyclone collectors



Schematic elevation shows view of electrolytic tin plate unit used to put coatings of different thicknesses on each side of tinplate.

Dust is formed from the blowing of galvanized pipe with steam at 150 psi to make a smooth coating. It is gathered by suction from two 12,000-cfm exhaust blowers, and then twin cyclone collectors separate the heavier particles. The finer material is collected by washers.

The use of substitutes for palm oil in the cold rolling of steel advanced appreciably during the year. Several oils have been developed which approximate very closely the composition of the palm oil, particularly, as far as properties are concerned. These materials have now either been tested or are now in use in the majority of tin plate mills in this country and Canada. Tests have been made involving all forms of application, direct solution and proportioning pump mixing with water, with uniformly good results, and with superior results to palm oil in some cases.

Another interesting lubricant development is an oil available in four viscosity grades designated as 50, 150, 675 and 40M. These are oils which gradually volatize at temperatures above 400 F. The unique feature is that they leave no residue as they volatize. These oils have been used in aluminum foil mills for lubricating rolls and foil. Since the oil on the foil surfaces evaporates completely during annealing, no elaborate cleaning is required for the annealing operation. The oil is also used on stainless.

The cleaning of hot rolled strip at one plant has been made more economical with the installation of a shot blasting unit in the strip pickling line. This can easily handle coils of about 16,000-lb capacity. With strip speeds up to 75 fpm, an average of 6 tons per hr can be cleaned. One of the chief elements in the cost reduction is the elimination of scale breaking on straight chrome grades. Other advantages are reduced manpower, lower maintenance costs, reduction of floor area, improved quality, etc. All grades of stainless have been cleaned with this line.

Abrasive scouring for the production of a mirror-like finish on stainless steel has been finding favor. This is not essentially a removal operation, but it is primarily a surface conditioner. In one installation, 320 and 400 grit silicon carbide paper is fed under pressure at 3 to 6 ipm, while strip moves at speeds from 50 to 200 fpm. Both sides of 30-in. strip are scoured simultaneously. The mill's main elements consist of three scouring stands in tandem.

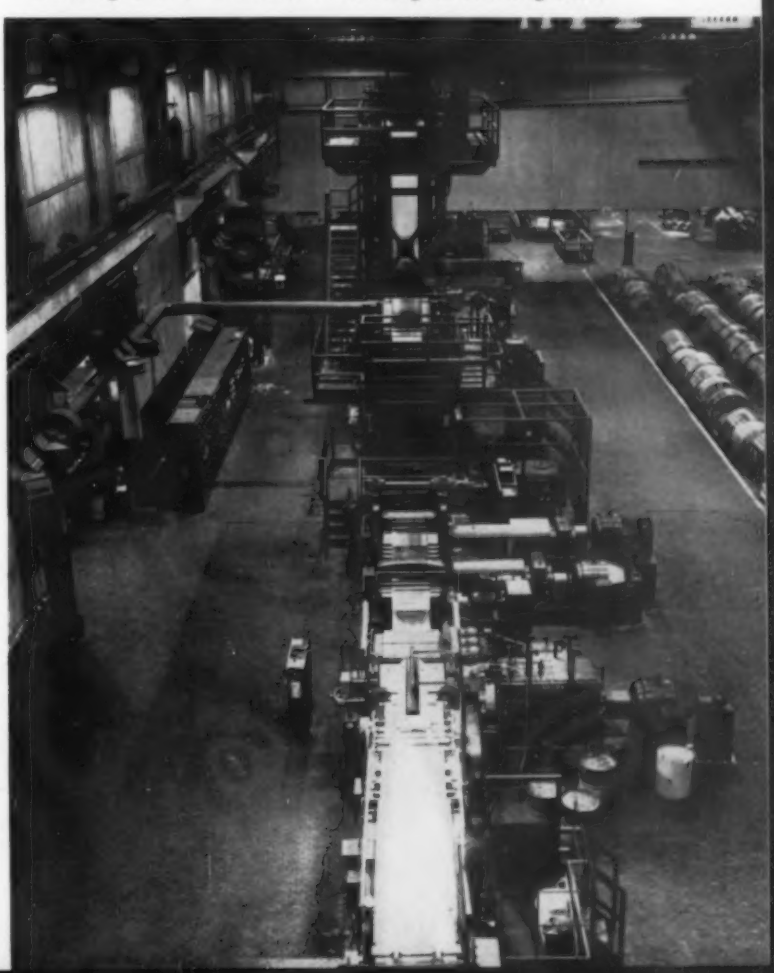
Induction heat has been used to remove surface scale from metal parts after heat treatment. The principle is to raise the temperature of the surface scale so fast that its expansion causes it to flake off from the cooler base metal.

A simplified low cost rotary coil pickling unit has been designed for handling from 5000 to 18,000 tons per year of commercial grades of coiled hot rolled strip in widths from 2–14 in., and in gages from 0.042 to 0.188 in. In this equipment, users of coiled strip can do their own pickling and coiling economically. Small space is required for the rotary coil pickling plant.

A British steel company put into operation a pilot plant which will make 40 per cent sulphuric acid from copperas obtained from waste pickle liquor. The copperas is roasted in the process to obtain sulphur dioxide. This is passed with air through water containing manganese sulphate which acts as a catalyst between the gas, air and water. These react to form the acid.

A method of hot dipping iron and steel in aluminum was described which has been under development for the past three years. In the process, the steel strip goes

Delivery end of a modern electrolytic tinning line.



through bluing furnace, a hot muriatic acid pickling bath, cold and hot water rinses, scrubbing, a dryer, a preheat furnace which heats the steel to 1350 F in an atmosphere of about 90 per cent nitrogen and 10 per cent hydrogen, then into a coating bath through an airtight chute, and then out through a cooling tower. The pickling bath removes all mill scale and oxide from the sheet.

In 1951, only 1000 tons of aluminum were used for such hot dip aluminized steel. However, it is predicted that by 1960 more than 80,000 tons of aluminum will be thus used.

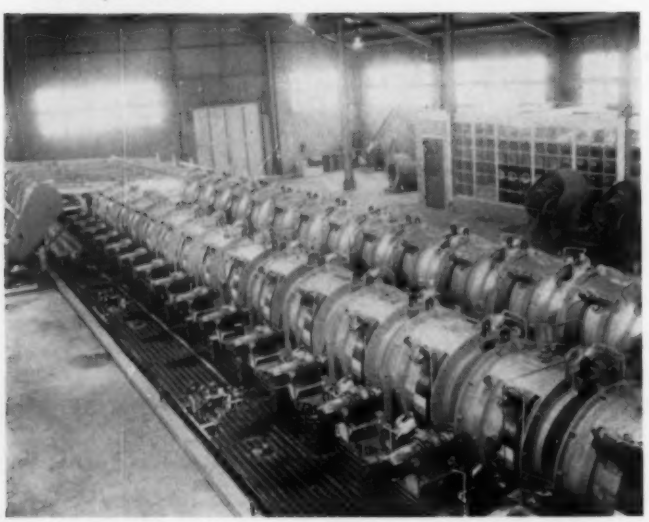
Another method for dipped coating of steel in aluminum has gone into successful commercial use at a large automotive company. In this particular process, the ceramic or refractory lining is the key. By allowing the bath salts to permeate into the brick network, the lining is thus of the same materials used in the process, and there is no contamination of the bath. In the process, an alkaline cleaner is first used, then a hot water rinse, and an acid pickling. A cold water rinse is next, followed by a hot water rinse. The part is dried, and then dipped for preheating into a ceramic-electrode salt bath furnace. Preheat bath also has some aluminum at the bottom. When taken out a silvery sheen can be detected on the material. The material is then transferred to the aluminum bath which is heated by a circulating-induction furnace.

The National Bureau of Standards also announced a practical process for the electrodeposition of aluminum at room temperatures. This results from a new type organic plating bath which consists of lithium hydride or lithium aluminum hydride added to an ethyl ether solution of anhydrous aluminum chloride.

Another development of the government are evaporation techniques which help electroplatings and solders to adhere to oxide-coated metals and glass. The technique should be helpful in coating metals such as aluminum, chromium and titanium. Advantages of the process are those associated with high vacuum evaporation techniques.

A new tin-nickel alloy coating process went into operation during the year. This coating consists of two parts of tin and one part of nickel. It has good metallic luster and a faint rose pink color, is hard, is as untarnishable as chromium, and can be deposited bright in one operation. Because of the current shortage of nickel, it provides an attractive substitute. Two such plants for this coating process have been set up in England, and in America the first commercial plant is ready for use.

Double line high temperature-high speed heating unit at the Gary Works of the National Tube Co. is rated 40 tons per hour.



Single stack, portable base, high convection annealing furnaces are very flexible in operation.

FURNACES AND CONTROLS

Research work is being undertaken on flame radiation on a test furnace made available by the Royal Netherlands Steel Works at Ijmuiden, Holland, for an international cooperative project. The primary object of this work is to determine the mechanism of luminous flame radiation. This is hard to determine, although it is fairly easy to predict non-luminous radiation which arises almost entirely from carbon dioxide and water products of combustion.

The designer is not satisfied with the low emissivity which results from a non-luminous flame, so he tries to increase heat transfer through development of a luminous flame, or in other words a flame which contains carbon particles due to combustion and thermal cracking and to incomplete combustion. The emissivity of luminous flame may be five to ten times that of a non-luminous flame. The importance of this determination can be easily seen, since the radiation which is given out during the process of combustion is dependent on the rate at which combustion is taking place. The knowledge required can be studied experimentally only in a full scale furnace.

As a result of this work it is hoped that theory of heat transmission and establishment of laws of luminous flame radiation can be obtained. The work is divided into three phases, namely, full scale work in progress at Ijmuiden, model work and laboratory work. One of the main general conclusions is that although there may be a small difference between the burners tested,

these are unimportant when compared with the effects of varying the quantities of atomizing agents.

Continuous annealing lines may be speeded through the use of direct-fired radiant gas heating equipment, so that strip can be run at a rate up to 1000 fpm. Such gas heating may be indirect, using radiant tubes, or direct-fired with radiant refractory panels. The results are uniform physical properties, with improved drawability of the continuous annealed strip, in a universal temper which is designated as temper TU which is ordinarily applicable where tempers T1 to T4 are usually specified. Success of such units depend on high speed heat transfer. Furnaces are constructed with two vertical heating panels which form a closed combustion chamber. Temperature of the incandescent radiation burner cup surfaces is controllable from 1300 to 3100 F by fuel input regulation.

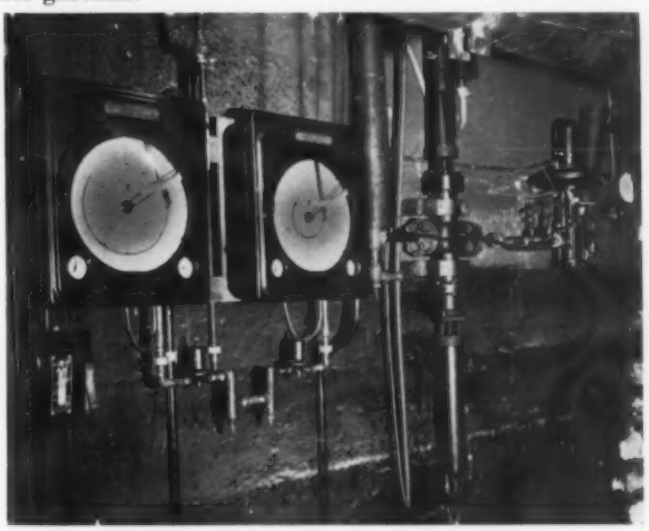
The application of high speed heating methods in the form of new heating units, particularly in furnaces designed to heat steel rounds, has resulted in economy in heating plus better quality of product. Development work on such equipment has also brought out a number of new heating principles. Among these are that accepted rules of heating steel to forging temperatures can be applied only to a specific type of furnace. In addition, the heating formula that is now used throughout the industry should contain a factor which involves the number of sides exposed to heat radiating surfaces. This in turn means that large quantities of fuel must be burned in small furnace volumes to maintain furnace temperatures in order to transmit the heat through several sides at the same time. High speed heating has a definite effect on the power required to deform metal, and comparative tests indicate that one-fourth less power is required to pierce fast heated rounds than slow heated or soaked rounds.

Production has been increased at one plant with a new six-zone continuous carbon restoring annealing furnace. Increase varies from 112 to 240 per cent. In addition, there is greater uniformity of surface carbon and shorter cycles. Furnace is designed to handle bars up to 6-in. diam, and coils up to 54-in. diam. The atmosphere can be controlled, and the time in the furnace will vary from 1 to 24 hr depending on how it is set. Prior to the installation of this unit, all carbon restoration annealing was done in batch type car-bottom furnaces. Heating is done through standard "W"-shaped alloy radiant tubes equipped with multi-pilot gas burners.

A new type viscosimeter has become available, whose range is unusually wide and which is capable of giving practically instantaneous indication. In this instrument, viscous damping exerted by a liquid on oscillating flat plate is measured by an electromechanical transducer. The piezoelectric voltage at the electrodes is proportional to the amplitude of vibration. This instrument can then be calibrated against liquids of known viscosity. Accuracy is claimed within 5 per cent.

One of the conclusions from the President's Materials Policy Commission report points to a reemergence of coal in stronger demand, as supplies of petroleum and natural gas inevitably begin to decline. Constant research and development should ultimately enable industry to create synthetic liquid and high heat gaseous fuels out of coal resources, at costs which are competitive with natural supplies. Another future trend is that the country must find out how to use lower and lower quality resources.

The continuous drive to develop synthetic gasoline has resulted in a debate on production costs between the Bureau of Mines and the National Petroleum Council. Last year the Bureau of Mines advocated an immediate program of producing oil from coal and stated that synthetic gasoline could be made by coal hydrogenation at costs of 12¢ a gal. The National Petroleum Council places the estimated cost at 41¢ a gal on the basis of studies which were requested by Interior Secretary Oscar Chapman. Those participating in the studies spent over $400,000 on the survey, the most exhaustive ever made of snythesis cost. The difference between the two cost estimates lies in the fact that the Bureau of Mines estimated, for example, investment costs in one plant at $121,500,000 less than the oil industry experts. In addition, Bureau of Mines estimated $47,500,000 less for plant facilities, $55,000,000 less for housing and $19,000,000 less for working capital, start up expense and other capital charges. The Bureau of Mines also estimated $10,768,000 less per year than industry experience indicates for operating labor and maintenance costs. Based on these differences in costs, lies the differences in the cost per gal figures for gasoline.



View of viscometer used for viscosity control of fuel.

Industry group pointed out that the three major processes, coal hydrogenation, coal gasification, and the extraction of oil from shale were not new. For example, the mining and processing of oil shale for synthesis is presently carried on in some foreign countries. Both coal gasification and coal hydrogenation started in Germany. The hydrogenation process is sometimes called the Bergius process, and the gasification process is sometimes called the Fischer-Tropsch process. According to the oil industry, they estimate that gasoline made from oil shale would cost about 16¢ a gal compared with the wholesale price of 12¢ a gal of gasoline refined from crude oil. They believe that since the shale to gasoline cost is getting close to where it can compete, this process should merit serious consideration by the oil industry.

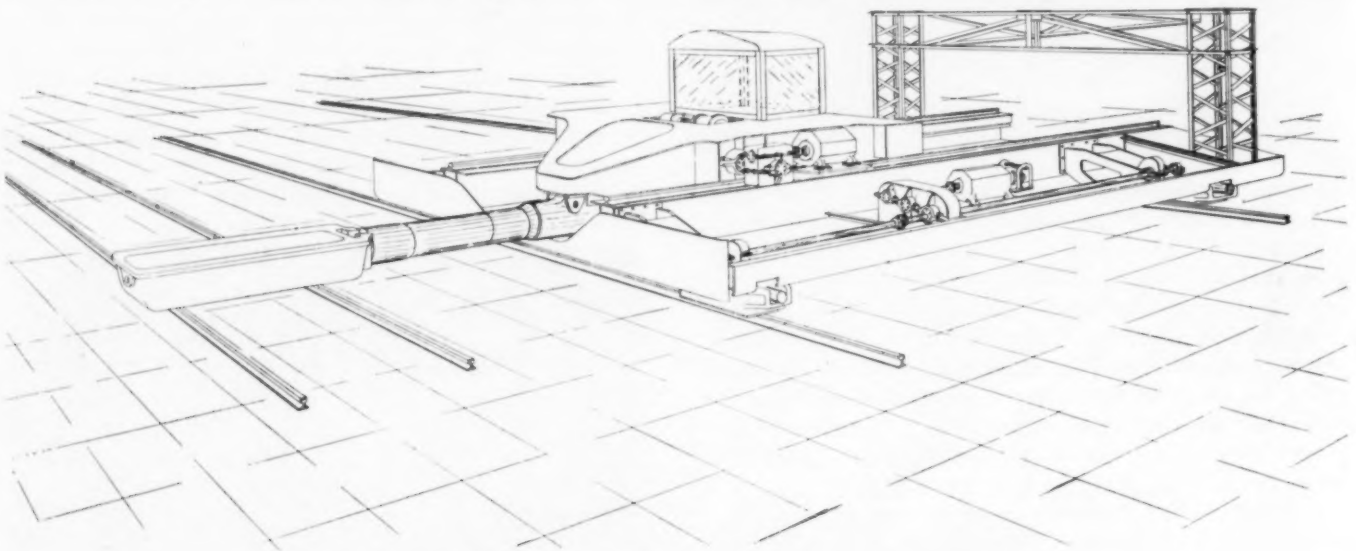
It is estimated that oil shale reserves will yield in excess of 100,000,000,000 bbl of oil.

Science is also being applied to materials handling equipment. One British crane builder is equipping some of his cranes with television so that the operator can see what is happening to the load. In addition, others are being equipped with radio, so that all three motions of the crane can be remote controlled at all times, two of them simultaneously if necessary.

A 120-ton traveling crane in a French plant has been equipped with thyratron control on the three motions. The control of this crane can be carried out from three different positions, one at the center and one at each end of the bridge. Actual operation consists of switching on the rectifiers by push button control and turning a controller to actuate a potentiometer. Controllers at the three positions are mutually interlocked to prevent operation of the crane from any post when the control of the remaining post is not in its neutral position.

The 15-ton capacity, low type open hearth charging machines built for Fairless have many novel features. In order to reduce the high wheel loads of such heavy machines, equalizer two-wheel trucks are used at each of the four corners of the charger, making a total of eight wheels instead of the usual four. All of these wheels are motor driven. A safety device is also provided on these chargers to stop travel in the event that workmen should be in the path of the machine.

A number of hydraulic charging machines have gone into operation and these represent a major design change in such units. Some of these units have the scrap boxes held on to the end of the peel with a clamping device together with the usual locking arrangement. Others have found that it is possible to eliminate the locking device. The clamping method prolongs the life of the peel head as well as the boxes. With such units, better visibility and better operation has been attained.



Schematic view of hydraulic open hearth charging machine.

The construction of the Fairless works led to requirements for some of the largest materials handling equipment ever built. Three 450-ton ladle cranes were ordered for this plant, of which one has gone into service, one is being erected and a third one is still to come. These are the largest ladle cranes ever built. A 30-ton pit crane, also believed to be the largest built, has gone into service. There are also three 200-ton metal-charging cranes of which two are in service. A 15-ton charging machine is in service and one is being erected. A 400-ton stripper crane is in service, one is being erected, and one will be delivered later. These 400-ton strippers, which are as large as any ever built, are also being used at the South Side works of the Jones & Laughlin Steel Corp. where two were installed this year, and one was also installed at the Pittsburgh Steel Co. plant in Monessen as well as at several other plants.

Although they may seem small in comparison with the cranes just mentioned above, two 350/60/25 ton, four-girder ladle cranes were delivered to Inland Steel during the year and one to Republic Steel Corp.

Illustrative of the trend in crane purchases are the units tabulated in Table III. This table lists all cranes purchased in 1952 by the steel industry, with the exception of those from two manufacturers.

In a 12-ton coal and ore handling bridge, built for a Canadian company, welding was utilized for the first time in the main ore bridge span. In this unit, most of the cross frames were shop welded, shipped to the site, and field erected by riveting. The span itself is considered to be 50 per cent welded.

A new simplified automatic ingot buggy went into production during the year at Republic Steel's Cleveland plant. This buggy receives the ingot from nine fixed locations and delivers it to a receiving table at the end of the track. The ingot cradle engages a cam at the end of the receiving table, and in the last few feet of travel, tips the cradle forward and deposits the ingot on the table rolls. The track and receiving table are in line so that the buggy stalls against the end of the table for discharge of the ingot. The 30,000-lb buggy travels at a maximum speed of 1200 fpm. A reliable control scheme provides complete intelligence for governing the speed of the buggy, such as traversing any given distance in the shortest possible time without overshooting, and stopping accurately at the desired position.

Another interesting development in materials handling is the use of a hydraulically elevated truck unloader which can unload coke from a trailer truck in

TABLE III

Partial Tabulation of Cranes, Trolleys and Bridges Purchased — 1952

No. cranes	Crane capacity		Speed, fpm			Type of bearings		Type of current and voltage	No. of motors	Motor sizes—60 min hp			Type of crane	Span, ft-in.
	Main, tons	Aux, tons	Bridge	Trolley	Hoist	Completely anti-friction	Partially anti-friction			Bridge	Trolley	Hoist		
1	2	.....	100	100	26	Yes	.....	a-c 440v	3	1¾	¾	4	Underhung	17
1	2	.....	150	65	26	Yes	.....	a-c 220v	3	1¾	4	4	Underhung	10-6
1	3	.....	250	.....	.....	Yes	.....	a-c 220v	1	3	.....	.....	Crane bridge	27-10¼
2	3	.....	.....	125	33	Trolley	.....	a-c 220v	2	.....	1½	7½	Transfer	.....
1	3	.....	200	125	33	Yes	.....	a-c 440v	3	3	1½	7½	Regular	35
1	3	.....	300	150	60	Yes	.....	d-c	3	8½	3	17	Mill	35
1	5	.....	175	125	32	Yes	.....	a-c 550v	3	5	3	15	Regular	46-10
1	5	.....	175	125	32	Yes	.....	a-c 550v	3	5	3	15	IR Trolley	33
1	5	.....	175	150	20	Yes	.....	a-c 220v	3	7½	3	7½	Single I-beam	39-10
1	5	.....	175	125	32	Yes	.....	a-c 550v	3	3	3	15	Regular	40
1	5	.....	175	125	23	Yes	.....	a-c 200v	3	5	1½	10	Regular	54-7½
2	5	.....	170	100	30	Yes	.....	a-c 440v	3	5	1¾	15	Regular	57
1	5	.....	250	.....	.....	Yes	.....	d-c 230v	1	4½	.....	.....	Transfer	38
1	5	.....	250	.....	.....	Yes	.....	d-c 230v	1	4½	.....	.....	Transfer	40-7
1	5	.....	300	125	56	Yes	.....	d-c 230v	3	15	3	25	Regular	56
1	5	.....	250	125	48	Yes	.....	a-c 220v	3	7½	3	20	Regular	50
1	5	.....	200	125	20	Yes	.....	a-c 220v	3	5	1½	7½	Regular	35-8
1	5	.....	.....	125	23-46	.....	.....	d-c 230v	2	.....	2	10	Crane transfer	.....
1	5	.....	200	125	32	Yes	.....	a-c 208v	3	5	3	15	Regular	55-4
1	5	.....	100	150	125	Yes	.....	a-c 220v	3	5	3	7½	Single I	40
1	5	.....	200	125	32	Yes	.....	a-c 220v	3	5	3	15	Regular	41-10
1	5	.....	200	125	32	Yes	.....	a-c 220v	3	5	3	15	Regular	60
1	5	.....	200	125	12-24	Yes	.....	d-c 230v	3	4½	1	4½	Regular	41-5
1	5	.....	175	2@100	2@33	Yes	.....	a-c 220v	5	5	@2@1	2@7½	Double Tr	60
1	5	.....	175	.....	2@33	Yes	.....	a-c 220v	3	10	.....	2@7½	Twin hoist	60
1	5	.....	200	125	20	Yes	.....	a-c 220v	3	5	1.5	7.5	Regular	50
1	5	.....	200	125	17	Yes	.....	d-c 230v	3	3	1	7.5	Regular	18-6
1	5	.....	300	125	32	Yes	.....	a-c 220v	3	7½	3	15	Regular	54-4
1	5	.....	175	.....	.....	Yes	.....	d-c 115v	1	3	.....	.....	Single I-beam	17-2
1	5	.....	160	100	24	Yes	.....	d-c	3	2	1½	10	Light duty industrial	27-6
1	5	.....	160	100	24	Yes	.....	d-c	3	2½	1½	10	Light duty industrial	43-6
1	5	.....	400	200	90	Yes	.....	a-c 440-3-60	3	25	5	40	Foundry service	70
1	5	.....	450	150	50	Yes	.....	a-c 440-3-60	3	20	5	20	Mill	56-11
1	5	.....	300	200	100	Yes	.....	d-c 230v	4	13½	6½	2-33	Grab bucket	54
1	6	.....	390	150	2@70	Yes	.....	a-c 440v	4	20	3	2@40	Double hoist regular	57
1	6	.....	.....	500	60	Yes	.....	d-c	2	.....	17	30	H.O. trolley	.....
1	7½	.....	175	125	20	Yes	.....	a-c 220v	3	3	3	15	Regular	15
1	7½	.....	250	125	32	Yes	.....	a-c 220v	3	15	3	20	Twin-hook regular	80
1	7½	.....	400	125	50	Yes	.....	a-c 440v	4	20	2	20	Mill	70
1	7½	.....	400	125	50	Yes	.....	a-c 440v	4	20	2	20	Mill	56-4
1	8	8	400	200	150	Yes	.....	a-c 440-3-60	4	40	10	60	Bucket	75
2	10	.....	300	100	24-60	Yes	.....	d-c 230v	3	10	3	20	2-Hook regular	47-4
1	10	.....	200	125	16	Yes	.....	a-c 220v	3	10	3	15	Regular	65-6
1	10	.....	300	125	36	Yes	.....	a-c 220v	3	10	5	30	Regular	57-3
1	10	.....	250	125	20	Yes	.....	a-c 440v	3	10	3	20	Regular	57
1	10	.....	.....	.....	20	.....	.....	d-c 230v	1	.....	.....	20	IR trolley	.....
1	10	.....	.....	125	24-48	.....	.....	d-c 220v	2	.....	3	20	Crane trolley	.....
1	10	.....	175	125	16	Yes	.....	a-c 440v	3	7½	3	15	Regular	56-10
1	10	.....	300	125	36	Yes	.....	a-c 220v	3	15	5	30	Regular	68-6
1	10	.....	250	125	24	Yes	.....	a-c 440v	3	7½	3	20	Regular	45
1	10	.....	300	125	32	Yes	.....	a-c 220v	5	10	2@3	2@15	Double trolley	40
1	10	.....	290	125	32	Yes	.....	a-c 220v	5	10	2@3	2@15	Double trolley	65
1	10	.....	300	125	32	Yes	.....	a-c 220v	5	10	2@3	2@15	Double trolley	50
1	10	.....	250	125	36	Yes	.....	a-c 220v	3	15	5	30	Regular	80
2	10	10	450	250	225	Yes	.....	a-c 440-3-60	4	100	15	125	Bucket	96
1	10	.....	350	150	40	Yes	.....	d-c 230v	3	33	6½	33	Mill	50
1	10	.....	350	150	40	Yes	.....	d-c 230v	3	27½	6½	33	Mill	75-6
1	10	10	275	200	75	Yes	.....	d-c 230v	4	45	13½	45	Mill bucket	85-6
1	10	5	300	150	30	Yes	.....	d-c 230v	4	27½	6½	27½	Mill	75-6
1	10	.....	100	435	97	.....	Except axles	d-c 230v	6	4-45	3	100	Storage gantry	93-6
4	10	.....	350	150	47	Yes	.....	d-c	3	17	3	39	Mill	39-9
1	10	.....	350	200	85	Yes	.....	d-c	3	65	10	65	Mill	96-1½
1	10	.....	500	200	90	Yes	.....	d-c	3	55	8½	70	Mill	100
1	10	.....	500	200	90	Yes	.....	d-c	3	55	8½	70	Mill	100
1	10	.....	500	200	90	Yes	.....	d-c	3	39	8½	70	Mill	77
1	10	.....	500	200	90	Yes	.....	d-c	3	39	8½	70	Mill	77
3	10	.....	.....	150	40	Yes	.....	d-c 230v	2	.....	4¼	30	Mill trolley only	.....

TABLE III — (Concluded)

Partial Tabulation of Cranes, Trolleys and Bridges Purchased — 1952

No. cranes	Crane capacity		Speed, fpm			Type of bearings		Type of current and voltage	No. of motors	Motor sizes—60 min hp			Type of crane	Span, ft-in.
	Main, tons	Aux, tons	Bridge	Trolley	Hoist	Completely anti-friction	Partially anti-friction			Bridge	Trolley	Hoist		
1	10	.....	250	125	30	Yes	.....	d-c 230v	3	10	6½	19	Mill	56
1	15	.....	250	125	35-70	Yes	.....	d-c 230v	3	4½	2	15	Regular	23
1	15	.....	250	125	20-40	Yes	.....	d-c 230v	3	7½	4½	25	Regular	35
1	15	.....	400	Bridge	.....	Yes	.....	d-c 230v	1	40	.....	.....	Pickling	72-4
1	15	.....	300	175	40	.....	Except axles	d-c 230v	4	2-33	19	65	Charging gantry	25
1	15	.....	300	150	40	.....	Except axles	d-c 230v	3	45	10	45	Cast house	60
1	15	5	300	150	30/60	.....	Except axles	d-c 230v	4	33	6½	33/19	Mill crane	56-3
2	15	.....	300	200	45	Yes	.....	d-c	5	25	5	25	Mill	70
1	15	.....	300	150	38	Yes	.....	d-c	3	55	11½	55	Mill	96
1	20	.....	250	125	24	Yes	.....	a-c 220v	5	15	2@3	2@20	Regular double trolley	48-8
1	20	5	.....	125/150	15/30 23/46	.....	.....	d-c 230v	3	.....	4½	25 & 10	Crane trolley	.....
1	20	5	350	110	24	Yes	.....	d-c 230v	4	45	6½	45	Mill	70-1
1	20	10	350	175	30/60	.....	Except axles	d-c 230v	4	65	19	45/45	Stockyard	65-3
1	20	20	Trolley	15	100/50	Yes	.....	d-c 230v	3	.....	15	100/50	Skull cracker	Trolley
1	20	5	350	150	70/140	Yes	.....	d-c 230v	5	45	19	2-65/65	Warehouse	48
1	25	.....	350	200	50	Yes	.....	d-c 230v	3	100	19	100	Mill	55
2	25	.....	300	150	25	Yes	.....	d-c 230v	3	45	10	65	Mill	66
1	25	15	400	200	34/50	.....	Except axles	d-c 230v	5	2-45	33	65/65	Coil storage	96
1	25	10	150	100	9	.....	Yes	a-c 440-3-60	4	7½	5	20	Powerhouse	57-1
1	30	10	350	150	25	Yes	.....	d-c 230v	4	45	19	65	Mill	56-7
2	30	15	300	160	30	Yes	.....	d-c 230v	5	75	15	75	Bucket & magnet	75
1	30	.....	250	150	35	Yes	.....	d-c 230v	3	65	19	100	Foundry	61-6
1	30	10	350	150	23, 50	Yes	.....	d-c	4	39	11½	55, 39	Mill	55-6
1	30	.....	175	150	28	Yes	.....	d-c 230v	3	15	7½	65	Mill	72
1	30	.....	Hand	Hand	9	.....	Yes	d-c 230v	1	.....	.....	25	Powerhouse	41-6
1	35	.....	300	134	39	Yes	.....	d-c 230v	4	2-45	13½	100	Mill	100
1	40	5	60	30	6	.....	Yes	a-c 440-3-60	4	15	5	20	Gantry	48
1	40	15	250	150	18/40	.....	Except axles	d-c 230v	4	65	33	65/45	Foundry crane	67
1	40	10	100	100	6	.....	Yes	a-c 440-3-60	4	10	7½	25	Powerhouse	56-4
1	50	.....	150	75	25	Yes	.....	d-c 230v	3	100	15	50	Hot metal	66-6
1	50	10	150	100	5	.....	Yes	a-c 440-3-60	4	20	10	25	Powerhouse	33
1	60	10	200	125	22	Yes	.....	d-c 230v	5	2-45	19	100	Mill	64-9
1	60	.....	350	Bridge	.....	Yes	.....	d-c 230v	1	100	.....	.....	Mill crane	75-9
1	60	25	300	125	28/34	.....	Except axles	d-c 230v	4	100	33	135/65	Slag yard	75
1	60	20	250	150	50, 18	Yes	.....	d-c	4	65	33	100	Mill	68-6
1	60	20	250	150	50, 18	Yes	.....	d-c	4	65	33	100	Mill	71-8
1	70	25	250	150	18	Yes	.....	d-c 230v	5	2-100	33	100	Mill	100
1	75	25	300	125	26/52	.....	.....	d-c 230v	4	100	33	135/65	Roll shop	61
1	100	25	300	200	16/34	Yes	.....	d-c 230v	5	2-65	45	135/65	Mill crane	86
2	125	20	100	30	6	.....	Yes	a-c 440-3-60	4	40	15	50	Gantry	75-1
1	160	20	200	100	9/40	Yes	.....	d-c 230v	4	100	45	135/65	Mill machine shop	75
1	275	40	30	30	4	.....	Yes	a-c 440-3-60	4	60	50	125	Gantry	72

one minute. This is done by tilting both the tractor and the trailer to a 40 degree angle and dumping the coke into storage facilities where it is kept until processed. The equipment differs from the ordinary car dumper in that the truck is tipped longitudinally with the front end the highest, instead of tilting the car sideways as is done in the conventional dumper.

One company delivered six gas-turbine, electric locomotives to one of the railroads in the early part of 1952. These units are rated 4500 hp input into the generator for traction, but with a low ambient and high altitude, power plant can produce 5400 hp.

A new company has been formed in Ohio for the purpose of transporting coal by pipe line from the Ohio River to steel plants in the Youngstown area. The thinking on this line is based on the experiments that have been run on the line now in use at Cadiz, Ohio. This Youngstown line would be a much longer line, about 30 miles, and it is estimated that coal could be moved over this distance for about 50¢ a ton compared with the present cost of $1.50 a ton.

The plans for the Lake Erie, Ohio River conveyor belt line for carrying ore and coal which were blocked in the Legislative Committee of the Ohio Legislature may be revived again. Present discussion on this contemplates running the route to Cleveland instead of to

Trailers are quickly unloaded by hydraulically elevated truck unloader.

Lorain. The hope here is that the bloc of legislators in the Cleveland area may thus help push the conveyor belt line.

MECHANICAL

1952 was a very successful year in the production of power generating equipment. An unusually large number of steam generator turbine units were produced (two companies produced about 8,500,000 kw). Sizes are getting larger, and averaged 75,000 kw for electric-utility units. Two units under construction are rated up to 250,000 kw. The highest steam temperatures ever used in steam turbines were incorporated in two 145,000-kw, 3600 rpm units which were delivered to a large eastern utility. These units will operate with initial steam temperature of 1100 F.

In the gas turbine field, the highlight of the year was the installation of a 5000-kva gas fired unit with a simple regenerative cycle which is being used for central station power generation by a southwestern utility. A large number of gas turbines were produced during the year for power generation, for locomotives and for natural gas pipe line pumping.

Gas turbine units have now been developed which give efficiencies ranging from 16 per cent for the simple cycle unit to 26.5 per cent for the compound cycle unit. Late figures indicate that the cost of a new gas-turbine plant is approximately ¾ that of a comparable steam plant. Maintenance and service records on plants in operation have been very good.

Two gas turbine units have been in operation which use blast furnace gas for their fuel. One of these, in Baracaldo, Spain, supplies air for a converter in a steel plant. The net output of this unit is taken out as 26,500 cfm of air at 29 psig. Rated capacity is equivalent to 2000 kw and the unit has an efficiency of 25 per cent. The blast furnace gas is compressed in a separate centrifugal blower, driven through gears from the main shaft, to the desired combustion pressure of about 65 psig.

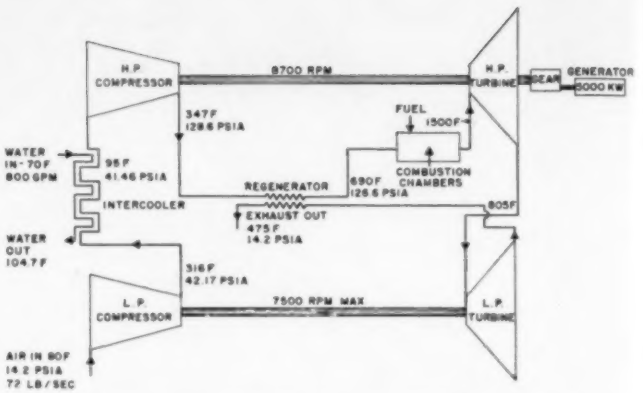
At Dudelange, Luxembourg, a gas turbine generator set has been installed in one of the main plants of the Arbed Steel Co. This is a 5400-kw unit with a design efficiency of 21.5 per cent. The gear driven axial compressor is also used here for compressing the blast furnace gas fuel. At both these plants, there have been no signs of any trouble.

Most of the cross frames in this 12-ton ore and crane bridge were arc-welded. Span is considered to be 50 per cent welded.

One of the largest power generating developments under way is one called the Ohio Valley Electric Corp. (a combination of several private companies) which will build two steam generating plants with a total power potential of 2,200,000 kw to supply the atomic energy plant in Pike County, Ohio.

The possibilities of generating electric power from nuclear reactors have received serious consideration during the year, and a number of proposals for such a plant have been released. One group of utility companies suggested a joint AEC privately financed plant which could be built under present conditions. Under this scheme, the AEC would pay for and own the reactor proper, and this is necessary in order to comply with the law which prohibits private construction or ownership of reactors. The utility companies would pay for and own the conventional facilities such as turbo-generators, condensers and switchgear. Intermediate facilities, such as heat exchangers, would be financed by the AEC as a grant-in-aid of construction. In addition, it is proposed that the AEC should make a grant which represents a difference between investment in the nuclear plant and investment the company would make in a comparable conventional power plant. This would be done in order to insure that the private companies take no undue risk which might result from such emergencies as lack of fuel.

Units which will develop power from nuclear plants are under way. One company has under construction or design three nuclear power plants of major size. One plant, a full size working model, is located at the national reactor testing station near Arco, Idaho. A second plant under construction will be used in the submarine Nautilus. In this plant nuclear energy will be used for large scale control power utilization for the first time. The third project under consideration concerns the design and development of another nuclear plant which is many times larger than the ones mentioned above, and would be suitable for powering major naval vessels such as aircraft carriers. Such a plant also would be the forerunner of the reactors which some day may produce power for central stations.

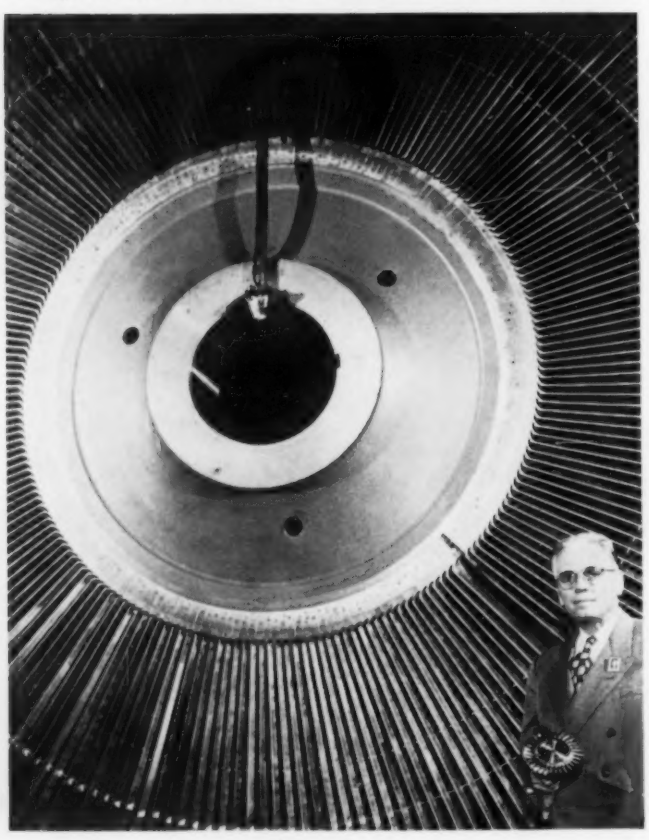


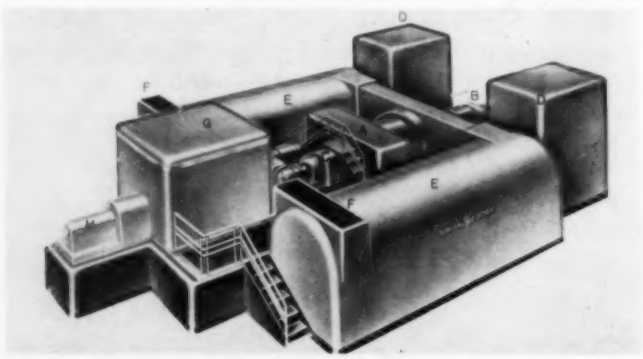
Pressures, temperatures and flows through 5000-kw, compound-cycle gas turbine are given in this schematic diagram.

Another atomic energy plant was shown to the public during the year in California, where North American Aviation's water boiler neutron source was demonstrated at the company's Downey plant. This unit is being used to further development. It is similar in construction and size to other low power water boiler reactors in the United States, but rating, of the unit of 1 watt makes a cooling system unnecessary. Production of atomic energy takes place inside a 1-ft diam stainless steel sphere which contains a uranium 235 enriched uranyl nitrate solution. From the nuclear fission of this material in a water solution, the reactor derives its power and its name water boiler. The rate of fission and the production of atomic power is controlled by a system of control rods which can be moved horizontally through the concrete and graphite to the core.

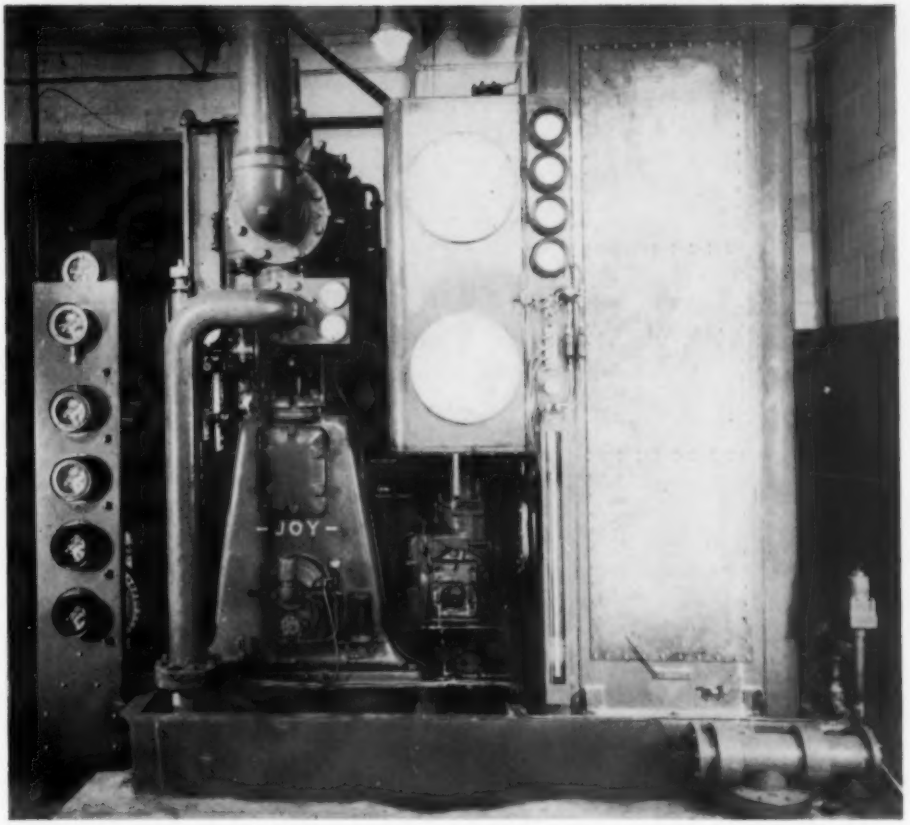
This company has also designed a larger reactor which is based on a unit with a relatively low energy release rate of 160 kw. Such a unit can be operated on one shift five days a week for ten years on a single uranium charge. Estimated reactor cost is about $1,000,000.

The smallest and largest turbine wheels manufactured by one manufacturer are shown in this illustration.





Artist's sketch shows 5000-kw compound cycle gas-turbine generator set. A is the gas turbine, B is the low pressure compressor, C is the high pressure compressor, D is the cooler, E are the regenerators, F are the exhaust ducts, G is the generator and H is the exciter.



Development of this semi-portable oxygen generator will enable oxygen users to produce their own high purity oxygen.

The first atomic central heating plant is in operation in England. In this plant, heat is drawn from a large experimental pile and transferred by constant flow of hot water through a heat exchanger system. Heat output is about 1,000,000 Btu and provides 130 F water for heating and sanitary facilities.

Another approach to the generation of power is an experimental unit which promises to convert coal to electricity in one step. This process eliminates turbines and generators. In the process, carbon is heated with steam to produce a gas which is fed into a fuel cell where it produces electricity directly by a method somewhat similar to the process which takes place in the storage battery. As the gas takes oxygen from one electrode, other oxygen to replace it, is absorbed from air passing the other electrode. The movement of oxygen from one side of the cell to the other produces electricity. It is believed that the new process can give twice as much electricity per lb of fuel as possible before. About 80 per cent of the fuel's energy is expected to be turned into electricity instead of the 35 per cent now available from steam plants. The process is satisfactory technically, but whether it will be satisfactory economically cannot be told until the trial runs have been made. Electricity, which is produced, is low voltage d-c and must be transformed for transportation purposes.

Advancement in the relief of troublesome deposits on boiler tubes from the firing of residual fuel oil has been accomplished in field operations. This has been done through the use of an additive to the oil. A material found effective is aluminum stearate, but economic consideration made its practical use doubtful. However, finely divided alumina, which is commercially available at a cost of about 3.25 cents per lb, was found effective when suspended in the fuel in the ratio of 1 lb of additive to 1 lb of ash solids. This has been borne out in large scale trials. The results of the alumina tests have shown that the deposits of the superheated region would change from a dense hard slag to a relatively soft ash, and that it may be possible to keep the unit on the line indefinitely if the furnace walls, screen tubes and superheater tubes were lanced with air at 225 psi about once a week. Tests have also been made using dolomite as the additive, with about the same results, except that with dolomite more of the fine powdery material was deposited in the first pass of the superheater.

Atomics are also being used in welding inspection. The development of radioactive isotopes for radiographic inspection of welds, forgings and castings allows the use of simpler and less expensive equipment than the normal x-ray procedure.

Radioactive tracers and isotopes are finding many uses. One interesting use is to find leaks in water lines. In this process, radioactive iodine is added to the water line and this leaks out at the break along with the water. By following the pipe above the ground with a detector, a concentration of radioactivity indicates a location for a leak. The same principle has been used in studying the effect of sulphur in coal in the various steelmaking processes. Another interesting use is to determine when to switch from one type of liquid to another which is going through a pipe line. When pipelines run slugs of various types of products, the use of radioactive material tells when one product ends and the other begins.

A new process was also announced during the year for purifying water for either industrial or domestic use where fresh water is not available. This is an ion exchange process. It is believed that the water is purified by causing the ions of the electrically charged

Jet pulverizer gives efficient fine grinding on existing boiler unit.

constituents of the undesirable minerals present in the original water to migrate into a by-product stream which is separated. The net result is to separate the flow into about two-thirds fresh water and one-third by-product. One application of this device is the purification of sea-water. This process has already been tried on sea-water which contains about 3.5 per cent salt. Power needed to make sea water drinkable is estimated at 20 kwhr per 1000 gal. Treatment of brackish water may require only one-fifth as much energy. Total operating cost on sea water with electric power at three mills has been estimated as low as 20¢ per thousand gallons for a relatively large installation.

A new semi-portable machine for making oxygen went on the market during the year. Machine generates high purity oxygen at costs which give savings estimated up to 50 per cent over previous type machines. Oxygen is made at operating costs of 5 to 10¢ per hundred cu ft or $12 to $24 a ton. Existing models will be built in sizes of one-half, two, six and twelve ton daily. The unique feature of these units is the self-cleaning heat exchangers.

A new electromagnetic pump that has no moving parts has been developed which will pump liquid metals and other conductive fluids of low resistance at temperatures up to 1000 F. Development can be used to move any fluid that has a resistance equal to or less than stainless steel. The principle of operation is that a current carrying conductor in a magnetic field is acted on by a force. In this case, the fluid acts as the conductor so when the proper combination of current and flux are applied, pumping action occurs.

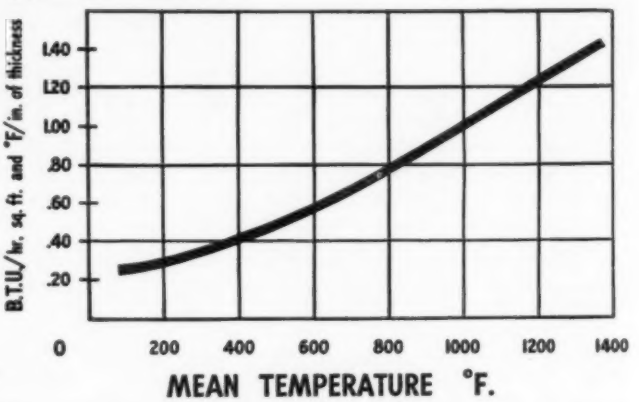
A new man-made ceramic fiber which possesses unusual resistance to heat, and unusual electric properties was developed during the year. This fiber is made by combining aluminum oxide and sand. It is believed that it will be a good substitute for asbestos in many applications. The material possesses great heat resistance and will not lose its properties at temperatures up to 2300 F. The material is a fluffy, white, cotton-like mass made up of random arrangements of extremely fine fibers, which are up to 3 in. in length, and have an average thickness of about one-fourth that of fine silk. Material weighs about 2 lb per cu ft.

The Navy has developed a plastic patch for pipe which can be applied in seven minutes and which will withstand working pressure within 20 minutes. This material consists of a fibrous glass cloth, resin, an activator and glass tape. No preparation is required other than to wipe the pipe dry. The patch will work over jagged ruptures and can also be used to join two ends of completely severed pipe. This application should be very helpful in maintenance work.

Work done by the National Bureau of Standards indicates that for the first time it will be possible to predict the rate of weight loss of a piece of steel corroding in soil. This will be done electrically without actually weighing the metal. Technique has extensive possibilities in both the laboratory and in the field. Using it will enable a person to determine whether a pipe needs to be replaced without excavating and examining the pipe beforehand.

Many new applications are being made to control the destructive effects of galvanic corrosion. Cathodic protection system using galvanic anodes is one of the simpler and more popular methods, and many plants are now installing sacrificial anodes to give such protection.

The problem of air pollution is usually so troublesome, because the equipment required is expensive and adds a net cost to the industrial process to which it is applied.



Thermal conductivity of new refractory fiber had a density of 6 lb per cu ft.

A new oxidizing catalyst has been developed and applied in small catalytic units which come in contact with stack gases. In one particular application, the fumes were consumed and the heat generated by the oxidation was recovered and returned to the bake ovens from which the fumes were derived. In this application, it was estimated that the cost will be recovered within six months. For the process to be successful, the catalyst must receive a certain amount of heat, and the fumes must contain elements which the catalyst can oxidize.

For the cleaning of smoke and removing particulate matter from a cupola, silicone impregnated glass bags were installed in a bag house. These successfully solved this smoke control problem for one company. Such silicone impregnated glass bags are expected to last two years in service.

It has been reported that a method has been developed for increasing the tensile strength of iron as much as six times, and at the same time improving its machinability. This process involves the addition of

ordinary salt and calcium silicide in order to get the same effect as is achieved by adding magnesium, which is to form nodular iron.

A new heat resistant alloy was developed during the year which has properties which permit engineering applications at temperatures up to 2200 F, or about 200 F over previous practical design limits. In addition, the material has greater resistance to oxidation under normal temperature fluctuations encountered in furnace operations. It thus has definite possibilities in furnace applications.

Modern machine tools have decreased production and maintenance costs.

A method has been developed for coating metals with tungsten carbide by means of flame plating. This provides the toughness of sintered tungsten carbide and is much more adaptable. It has a wear life up to five times that of sintered tungsten. The secret of the process is the low temperature used in the plating operation, as the temperature of the base metal never goes higher than 400 F. This eliminates warping and changes in the properties of the metal. Thicknesses can be varied from 0.0005 to 0.02 in.

The day of the automatic machine shop is rapidly approaching. One futuristic machine which has been developed by research engineers at the Massachusetts Institute of Technology was demonstrated during the year. The unit demonstrated is a milling machine using an electronic hook-up which runs without an operator. Dimensions from a drawing are translated and punched on an automatic tape in order to operate the machine. Thus the equipment will be particularly economical in mass production set-ups, since on repetitive operations, the time of tape preparation and equipment can be justified. This machine differs from most of the previously automatic controlled machinery which has usually been of the analogue type. These previous machines obtain their instructions from models or from measurements from a working drawing that is scanned with an electric eye. Such equipment can only be as accurate as the model or the drawing from which it is copied. This equipment on the other hand receives its instructions in the form of electrical pulses which represent numbers on a punched tape, and these numbers are derived directly from the specifications of the part to be machined, so that any tolerance within the range of the equipment may be obtained.

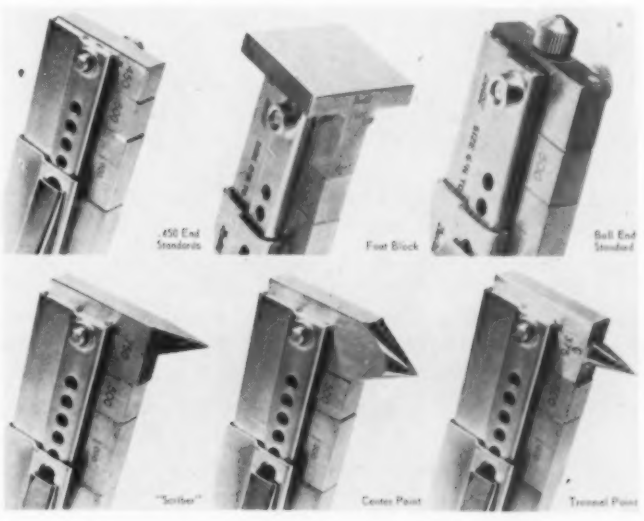
The engineers who have designed this machine believe the principles which operate it can be used as a basis for automatic control of any production process where the end product varies from day to day.

Hot machining has been greatly stimulated by a number of different techniques which have been developed. Most of these have their attendant advantages and disadvantages. In general, hot machining reduces tool wear, increases cutting speed and improves surface finish. However, it is difficult to make direct comparisons. In general, it has been found, for example in the case of stainless steel, that the total power requirements for hot and cold machining show that in hot machining, the sum of the power required for the machine tool and for heating is about the same as that required in cold machining for the machine tool alone. Therefore, the economic advantages must be based on other considerations, among which would be the amount of work which can be done with a given machine. In the case of stainless steel, the cutting force is reduced to one-third of that required in cold machining, indicating that the machine tool capacity would be tripled. Also applications, where machining of the work can be done while it is still hot from another manufacturing process, would have a definite advantage.

A new grinding process has been developed which does not require the present abrasives. This grinding process is a reverse electroplating process. The grinding wheel is a metal disc which is charged negatively and the work piece is charged positively. By introducing an electrolytic chemical such as sodium nitrate over the grinding surface, small particles flow from the work piece through the chemical and onto the wheel. Traces of bort may be used on the wheel to speed up the process. Large savings in grinding costs are claimed for the process. A kit is also sold which will convert standard grinding units to the electrolytic process. It is believed that this is originally a Russian development and large numbers of these units are reported in operation behind the iron curtain.

A similar process, an electro-erosive machining method which combines electrolytic and electro-arcing effects, is being developed at Frankford Arsenal. The machine can be used for cutting or grinding carbides. The unit now being built is capable of cutting, tool

A new type of gage block was developed during the year.



grinding, boring and chipbreaker grinding. The principal use will probably be for the shaping, finishing and regrinding of single point carbide tools. In the process, the cutting tool and work piece is surrounded by an electrolyte. The carbide is connected in a d-c circuit as the anode, and the rotating metal disc acts as a cathode. Cutting or grinding are achieved depending on whether the carbide is held against the edge or the side of the disc. The pressure on the work apparently has no effect on the cutting time. The electrolyte found most effective is sodium silicate. The process is primarily intended for high speed shaping of hard metals and carbides, and does not produce a good surface finish. It is believed that the process is predominately an arc cutting process.

Other new methods of machining difficult materials are the spark erosion method described in last year's story, electro-arcing, ultrasonic, and combinations of these methods. The electrolytic or electro-machining method is limited to materials which are conductive such as ordinary steels, and the carbides.

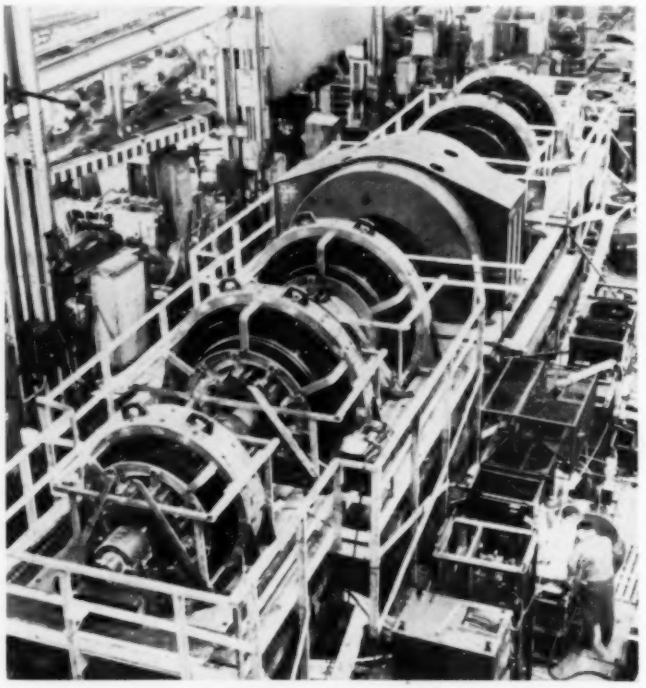
In the commercial electro-arcing process, the work is made the anode in an electric arc. The arc between the tool and the work is surrounded by a dielectric fluid. The pulsating electrical discharges heat the work by electron bombardment and the area under the arc gets very hot, vaporizing the metal and cracking off solid particles because of fast thermal expansion. Voltage is 25 or less d-c. Such electro-arcing techniques can be used to drill or tap holes from 0.02 in. diam up. Holes from 0.06 in. in diam or larger can be threaded. The fluid keeps the heating confined to the work area so that adjacent metal is not damaged. Electro-arcing can be used on any conductive material and has been used primarily on tool steels and cemented carbides.

Electro-sparking process seems very similar to the electro-arcing except for the voltages and the auxiliary equipment. The process is quite different, however. With electro-sparking, there is no burning of the metal, since the particles of the work are broken off by concentrated electrostatic forces, and the sparks jump through the surrounding fluid from the tool to the positively charged work. The fluid used is a dielectric. The difference between electro-arcing and electro-sparking is primarily a matter of degree. However with electro-sparking, extremely fine finishes can be obtained. The same shapes can be cut by both processes.

The ultrasonic process does not use electric current for stock removal. In this process the tool is made with an end shaped to the outline of the hole or contour to be cut. This tool is then vibrated at frequencies from 16,000 to 29,000 cycles per second through an amplitude of a few thousandths of an inch. The tool is pressed against the work, and a mixture of a finely divided abrasive, ordinarily boron carbide and water, flows around the work and under the end of the tool. Under light continuous pressure, the tool sinks into the work and forms a hole shaped like the tool itself. The tool is consumed during the process. This process can be used for non-metals and materials which are not conductive.

Another interesting machine tool development is a drill equivalent in size and power to conventional 17 to 20-in. drill presses, but which has a throat adjustable from 6½ in. to 14 in. The drill head revolves 360 degrees, both horizontally and vertically, and can be mounted either horizontally or vertically, on or under, the work table. Thus it is possible to drill holes in a piece of metal from almost any angle, and the set-up time is only a few minutes for any job. It is also possible to mount several drill heads together on the same work table, thus simultaneously being able to drill several holes at different angles on the same piece. Normally, such adjustable units are not too precise, but the manufacturer claims that this machine is as precise and durable as the best existing single machine.

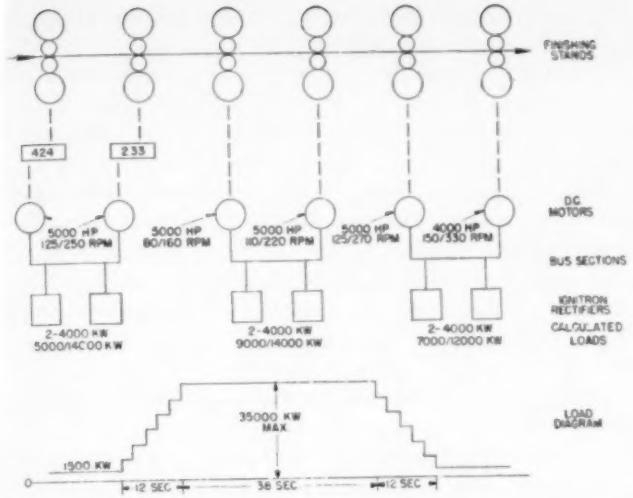
A development in sawing is the use of a toothless saw made from steel strapping. These saws are most efficient at high speeds. The action is due to the friction which heats the metal being cut to the melting point so that the blade burns its way through the piece.



This giant motor-generator set is rated at 10,800 kw and is driven by a 15,000-hp synchronous motor. It will supply d-c power for a 4-stand cold strip mill.

A very interesting bearing application was introduced into the country last year. This is a split roller bearing which has been long used in England, but not previously available in the United States. Bearings are made in halves throughout, and are therefore very simple and rapid to install and inspect. The bearings have the usual advantage of anti-friction roller bearings, but in addition, offer advantages to the designer. Machine design can be simplified and full use can also be made of the advantages of split housings on equipment. A second advantage is from the standpoint of maintenance, particularly in industries such as steel plants. Here the ability to quickly take the bearings apart and replace them without tearing down as much equipment as may be required normally, should result in decided savings in down time.

Another interesting bearing application is a new fluid piston type bearing which is used in pumps. It does not have to be made of bearing material nor lubricated with oil and grease. The primary use is for pumps that have to be lubricated by the liquid which is being pumped. Liquids may be hot, of low viscosity or corrosive. Power requirements are, however, rather high. The bearing



Arrangement of main drive motors and rectifier power supply for the 80-in. hot strip mill at the Fairless Works.

works on the principle that the liquid flows from the supply area into a piston chamber, then out between the edges of the chamber and the pump shaft. The pressure floats the shaft with a large running clearance. The so-called pistons consist essentially of pockets spaced around the circumference of the shaft, and normally four or more are used. They have an open end facing the shaft, and normal bearing clearance is provided between the journal and the box edges or piston lips. Thrust bearings which operate on the same principle have also been developed.

Another bearing development should reduce the number of hot boxes on railroad cars. This consists of a new shaft seal. They have been installed on a large number of cars equipped with roller bearings, and so far not a single bearing failure has been reported from the cars using these seals. In addition, there have been marked savings in lubricant requirements. Seals are also being developed for plain bearings.

In industry, there has been a trend toward the use of multi-purpose lubricants in order to reduce inventory. No universal grease has been found. However, the use of lithium-base multi-purpose greases has increased widely. A large number of the companies in the grease industry are now manufacturing this type, and one of the largest announced recently that about 60 per cent of its total grease production is in the multi-purpose lithium group.

The trend toward the use of these multi-purpose greases has had very important effects. Wheeling Steel Corp., for example, has reported that it has reduced the number of lubricants it uses from 375 to 130. It is still working to reduce this number as well. The Aluminum Co. has also been a pioneer in this type work. At the present time, about 75 per cent of the grease requirements in Alcoa plants are met by lithium-base multi-purpose lubricants. Eight greases, six lithium, one silicone and one bentone have passed the Alcoa tests. They are used in all types of friction bearings from 10 rpm to 3600 rpm and operate from 150 F to —20 F.

New high temperature lubricants developed by the office of Naval Research will permit continuous operation of motors at 300 F without lubrication for intervals of up to 1000 hr. With motor design changes, these intervals can be increased appreciably. These lubricants are silicone-lithium soap greases, and give good performance up to 6000 hr. At 100 F, they will last up to 15,000 hr.

A new wide-temperature range grease has also been produced by the Navy which is supposed to be good from 80 degrees below zero to 400 F. The base is copper phthalocyanine. Grease is reported to work satisfactorily at 425 F for periods up to 1000 hr.

The government reported that in some of its research they are making synthetic lubricants from turpentine. The government chemist combined an acid from turpentine with high boiling alcohols which form the lubricants. These are used as oils and as hydraulic lubricating fluids.

The problem of sludge in fuel oil is said to have been overcome by one refiner. The answer has been the development of an additive for domestic heating oil which not only reduces the formation of sludge, but disperses the refuse already present in most oil burning systems. The additive also helps prevent rusting.

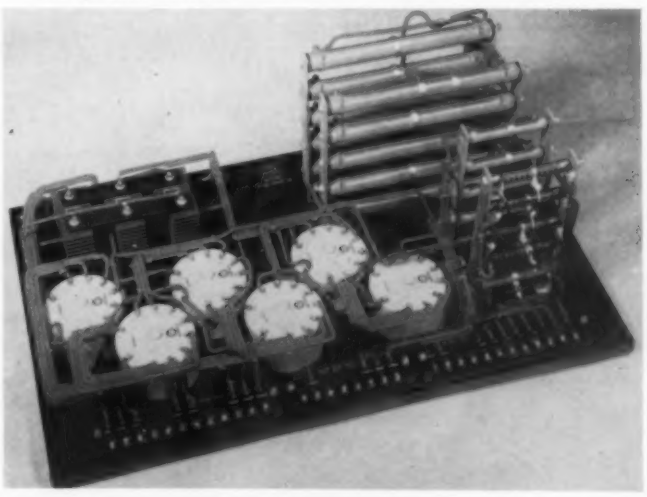
ELECTRICAL

At the beginning of 1952, total generating capacity was about 90,000,000 kw. Of this *utility* generating capacity was 75,972,736 kw, and utility plants produced 392,000,000,000 kwhr in 1952, compared with 370,234,000,000 kwhr in 1951. Industrial plant generating capacity was about 14,000,000 kw at the beginning of 1952. Power generated by industrial establishments totaled 62,000,000,000 kwhr compared with 56,000,000 kwhr in 1951. Total power generated by industry and utilities was about 454,000,000,000 kwhr compared with 426,000,000,000 kwhr in 1951.

Of the total power generated, industry used almost one-half, and the steel industry used about 6 per cent of all power generated. About 60 per cent of the power used by the steel industry was purchased, the remaining 40 per cent was generated.

The rate of growth of the use of electricity is much greater than the 3.3 per cent annual growth increase figure which applies to industry as a whole, as the use of electricity increases about 8 per cent every year. In

View of a 60-cycle magnetic amplifier voltage regulator for control of an 8000-kw ignitron rectifier for hot strip mill service.



the iron and steel industry, there had been an increase of 25 per cent in the past fifteen years based on kilowatt hours used. The use of electricity is limited by generating capacity, and to run all industries at full capacity would require 30 per cent more generating power capacity than is now projected on the power expansion program. This is true even though the electrical industry has now the largest backlog for generating equipment in their history, a backlog which extends into 1955.

Power companies are embarked on an unprecedented expansion program for the development of additional generating capacity.

The electrical expansion goal set by the DPA for Class I utilities increased in 1952 officially to 117,000,000 kw from the previous figure of 107,000,000 kw. The program adds 42,000,000 kw to Class I utilities for the four year period 1952 to 1956, 7,000,000 kw in 1952, 10,000,000 kw in 1953, 12,000,000 kw in 1954, 12,000,000 kw in 1955, and 1,000,000 kw in 1956. This latter item is primarily for the atomic energy plant under construction in Pike County, Ohio.

However, the expansion of electric power in 1952 fell about 1,300,000 kw short of the goal, which had scheduled installation of about 9,000,000 kw during the year. Some of this loss was due to the steel strike. Utility generating capacity at the beginning of 1953 was estimated at 83,700,000 kw.

The DPA estimated that peak load on utilities in 1952 would be 78,000,000 kw; in 1953, 85,000,000 kw and in 1954 would be 91,000,000 kw.

The Class I utilities produce about 95 per cent of the total power used by the public. This Class I group, however, does not include industrial power plants and small public utilities.

About 77 per cent of all power is generated in steam plants, and about 23 per cent by water power. The percentage developed from water is increasing. Most of these water installations are operated by utilities. For example, in 1950 the horsepower of water power available was 26,300,000 hp (18,200,000 kw) compared with 90,500,000 hp (63,500,000 kw) of thermal. In 1950, total water and thermal power was 116,800,000 hp (81,700,000 kw), central station horsepower was 97,000,000 (68,000,000 kw), and total industrial plant horsepower was 19,800,000 (14,000,000 kw). The 14,000,000 kw for industrial plant, in 1950 compares with 20,000,000 kw in 1920. This illustrates a trend to purchased power.

Total connected load in some plants is large. At the Fairless works, total connected load is 390,000 kw.

The world's fastest cold strip mill, scheduled to operate at about 80 miles per hr, at the Fairless works will have 21,650 hp on the drives. Mill will use six drives ranging from 1400 to 6000 hp. Each drive will be supplied with separate generators. The last stand will be driven by a twin drive unit using six armatures.

The attempt to use small diameter rotors on the last stand of the mill led to ventilating difficulties. By using circular rotor punchings, which are mounted directly on the shaft arms, maximum ventilation is given for a minimum of space.

Advances in motor design, have resulted in a request by one of the largest electric manufacturers to modify rating standards for motors. In some cases this company is redesigning its electric motors to double the horsepower without changing the frame size of the units. As a result, in November 1952, NEMA, approved new standards for 1800-rpm, open type motors, from 1-30 hp, in which increased horsepower is put in existing frame sizes.

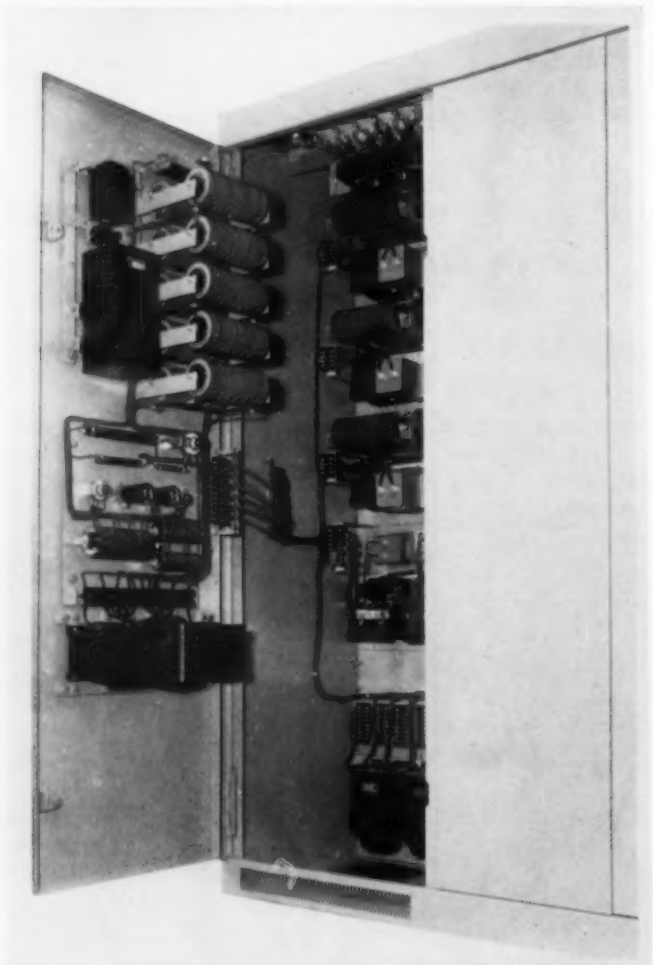
The development of AISE standard No. 11 which covers d-c mill motor brake standards adds to the AISE mill motor a standard brake. When these brakes go into production, all manufacturers' brakes will be interchangeable with respect to mounting dimensions, torque ratings and wheel dimensions. This standard culminates the work on the part of brake manufacturers and an AISE-NEMA committee which has lasted for several years.

One of the largest drives ever built consists of four electric motors which will have a total of 216,000 hp on a single shaft. The unit has 2-83,000 hp synchronous and 2-25,000 hp wound rotor motors. Another drive will have 4-45,000 hp motors. Peak one-hour output of this unit will be 216,000 hp. Both drives are being built for wind tunnels.

An interesting development is the application of a new alloy for generator rotor windings, which enables the design of 3600-rpm generators which are 20 per cent larger than could be made with copper windings.

A magnetic amplifier system will control a 66-in., four stand, tandem, cold reduction mill which is being built for the Pittsburgh Steel Co. This system will fur-

Amplistat voltage regulator for ignitron rectifier is mounted on door of excitation compartment.



nish excitation, and regulate accurately the generator voltage supplying the mill and reel motors.

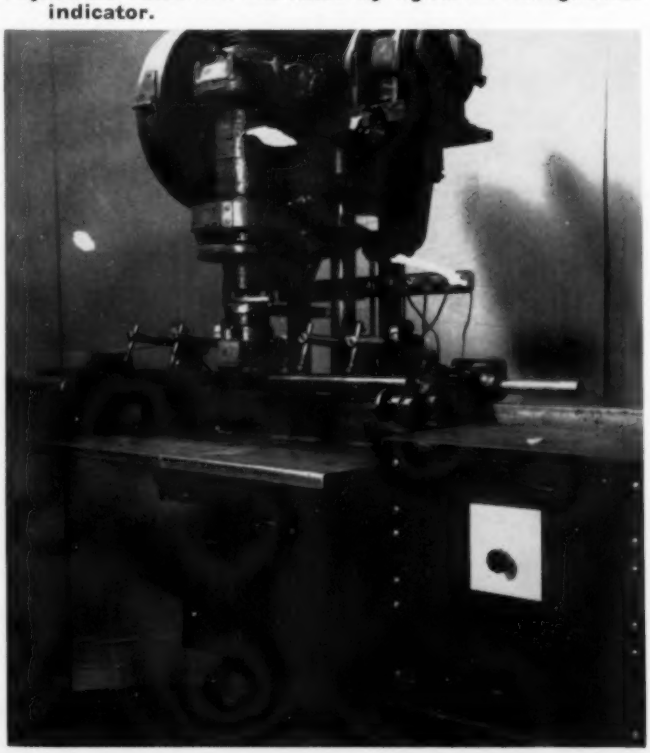
This mill is the first installation to have twin motor drives on all stands. By making the off-set gears of different ratios, the motors can operate at the same speed and be of duplicate design. Thus six duplicate 2250-hp motors will be used for the three 4500-hp twin drives at Stands No. 2, 3 and 4.

An interesting development in the design of transformers is a new system of cooling which should in some cases double the capacity of the transformers. In the system, a rectifier is hooked on to the coil plating and to outer casing of the transformer. The power line running into the transformer is tapped, and some current is fed into the rectifier. The rectifier changes a-c into d-c, setting up an electric charge within the transformer which is positive on the coils and negative on the outer casing. The oil which is used for cooling the transformer is in the middle between the two unlike charges and starts moving. The molecules of the oil are attracted to the coils where they pick up a positive charge and heat. Since the unlike charges attract, they now move toward the outer casing where they get rid of some of their heat and pick up a negative charge. They then head back for the coil and start the same cycle over again. Thus, the system sets up circulation within the transformer oil, and it is claimed that the method will cool the transformer ten times as fast as in previous methods.

Aluminum is being used in both experimental and commercial transformers, and has been substituted in dry type power transformers, sample regulators and distribution transformers. An aluminum wound dry type transformer must have about 60 per cent more aluminum conductor area than that with copper. In addition, from 7 to 10 per cent more iron is required. The windings weigh from 50 to 58 per cent as much as the standard copper design, and the overall weight of the transformer is reduced up to 5 per cent.

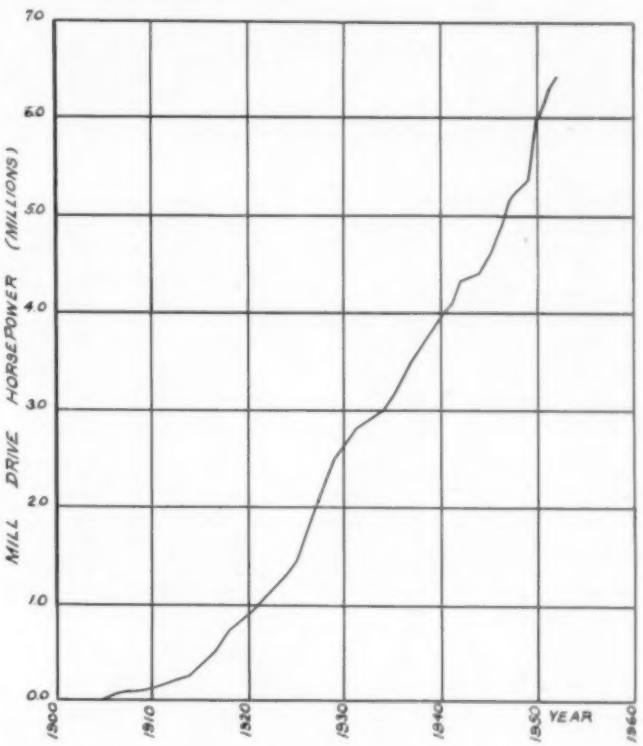
A vapor-cooled transformer is nearing completion. This is a 500-kva unit which is being built for experimental service.

Rejectable tubes are indicated by lights on straightness indicator.



National Bureau of Standards developed a new type of rectifier recently which may be the first major improvement in metal-oxide rectifiers since 1926. The new rectifier consists of a layer of semi-conducting titanium dioxide, a sheet of titanium metal, and a counter electrode of some other conducting metal. Preliminary investigations have shown interesting new properties in that the new rectifiers can withstand reverse voltage up to about 20 volts per plate. They have good properties at elevated temperatures, and their performance is actually improved when increasing the temperature up to about 170 F.

The Naval Ordnance Laboratories Magnetics Division developed a new magnetic material called bismanol. This is an alloy, manganese bismuthide, made up from powdered bismuth and manganese. The material has a coercive force of 3000 oersteds.



The cumulative curve of main drive motors over 300 hp shows a total to January 1, 1953 of 6,399,890 hp. Forty-nine motors (71,800 hp) were added in 1952, or about one-fourth the total added in 1951.

Many interesting and clever devices have been developed for various types of inspection and testing operations. The x-ray thickness gage is quite well known, however, there are many other units. Devices have been developed which will indicate the depth of the welded seams in welded tubing. Other units are available which will sort different types of steel in mixtures. Other units give automatic length control and rejectable shorts are eliminated.

Summarizing, 1952 was a very active year in the history of the steel industry. Much of the work done, however, had been contracted for in the previous year. As a result, sales of main drives, for example, were only about one-fourth the previous year. The additional horsepower supplied by the main roll drives furnished during 1952 totaled 71,800, furnished by 49 motors of which 41 were d-c and 8 were a-c.

ELECTRIC MOTORS OVER THREE HUNDRED HORSEPOWER

APPLIED TO MAIN ROLL DRIVES IN THE IRON AND STEEL AND ALLIED INDUSTRIES DURING 1952

Item	Horsepower	Revolutions per minute	Volts	Frequency	Method of drive	Type of mill	Purchaser	Location	Manufacturer
1	①②300	400/700	500	d-c	Direct	42-in. Temper mill	National Steel of Brazil	Volta Redonda, Brazil	General Electric
2	①②300	400/700	500	d-c	Direct	42-in. Temper mill	National Steel of Brazil	Volta Redonda, Brazil	General Electric
3	①②300	400/700	500	d-c	Direct	42-in. Temper mill	National Steel of Brazil	Volta Redonda, Brazil	General Electric
4	①②300	400/700	500	d-c	Direct	42-in. Temper mill	National Steel of Brazil	Volta Redonda, Brazil	General Electric
5	①②300	400/700	500	d-c	Direct	Tension temper mill	National Steel of Brazil	Volta Redonda, Brazil	General Electric
6	①②300	400/700	500	d-c	Direct	Tension temper mill	National Steel of Brazil	Volta Redonda, Brazil	General Electric
7	300	400/700	500	d-c	Geared	Tension reel	National Steel of Brazil	Volta Redonda, Brazil	General Electric
8	400	350/700	250	d-c	1:1 Ratio	Sendzimir mill	Seymour Manufacturing Co.	Seymour, Conn.	General Electric
9	*400	277	2300	60	Direct	Rod mill	Phelps Dodge Corp.	Bayway, N. J.	General Electric
10	*400	225	2300	60	Direct	Rod mill	Phelps Dodge Corp.	Bayway, N. J.	General Electric
11	400	400/1200	. . .	d-c	Geared	Cold aluminum strip reel	Aluminum Foils, Inc.	Jackson, Tenn.	Westinghouse
12	500	575/1260	600	d-c	Geared	86-in. Temper mill	Kaiser Steel Corp.	Fontana, Calif.	General Electric
13	500	300/900	600	d-c	Geared	Reel drive	Kaiser Steel Corp.	Fontana, Calif.	General Electric
14	500	350/1045	250	d-c	Geared	Tandem cold strip mill	Blair Strip Steel Co.	New Castle, Pa.	General Electric
15	600	375/765	230	d-c	Geared	Armor plate roller leveler	Lukens Steel Co.	Coatesville, Pa.	Westinghouse
16	†600	450/900 600/1200	440	60	Geared	26-in. Hot breakdown mill	Fansteel Metallurgical Corp.	N. Chicago, Ill.	Elliott
17	†800	720	2300	60	Geared	12-in. Bar mill	Copperweld Steel Co.	Warren, Ohio	Westinghouse
18	†1000	885	2300	60	Geared	18-in. Roughing mill	Republic of Philippines	Philippine Islands	Westinghouse
19	①1000	500/1000	500	d-c	Geared	56-in. Temper pass mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	Westinghouse
20	①1000	500/1000	500	d-c	Geared	56-in. Temper pass mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	Westinghouse
21	②1000	170/680	625	d-c	Direct	56-in. Temper pass mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	Westinghouse
22	②1000	170/680	625	d-c	Direct	56-in. Temper pass mill reel	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	Westinghouse
23	1000	400/800	600	d-c	Geared	Skelp mill	Wheeling Steel Corp.	Benwood, W. Va.	Elliott
24	1000	300/900	600	d-c	Geared	Aluminum foil mill	Kaiser Aluminum and Chemical Corp.	Permanente, Calif.	Elliott
25	1000	300/850	600	d-c	Geared	Steckel mill	Cold Metals Products Co.	Indianapolis, Ind.	Elliott
26	②1200	200/800	750	d-c	Geared	66-in. Tandem mill reel	Pittsburgh Steel Co.	Allenport, Pa.	Westinghouse
27	②1200	220/880	600	d-c	Direct	56-in. Tandem mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
28	1200	150/525	600	d-c	Geared	48-in. Reversing cold strip mill	McLouth Steel Corp.	Detroit, Mich.	General Electric
29	1200	150/525	600	d-c	Geared	48-in. Reversing cold strip mill	McLouth Steel Corp.	Detroit, Mich.	General Electric
30	1200	150/525	600	d-c	Geared	48-in. Reversing cold strip mill	McLouth Steel Corp.	Detroit, Mich.	General Electric
31	1200	150/525	600	d-c	Geared	48-in. Reversing cold strip mill	McLouth Steel Corp.	Detroit, Mich.	General Electric
32	*1250	900	2300	60	Geared	Sendzimir mill	Atlas Steels, Ltd.	Welland, Ontario, Canada	General Electric
33	1250	200/400	600	d-c	Geared	Cold strip mill	United States Steel Corp.	Vandergrift, Pa.	Westinghouse
34	1250	250/750	600	d-c	Geared	Winding reel	United States Steel Corp.	Vandergrift, Pa.	Westinghouse
35	1250	250/750	600	d-c	Geared	Winding reel	United States Steel Corp.	Vandergrift, Pa.	Westinghouse
36	†1250	600	6600	50	Geared	Scale breaker	National Steel of Brazil	Volta Redonda, Brazil	Westinghouse
37	②1400	90/270	270	d-c	Direct	Edging mill drive	Inland Steel Co.	Indiana Harbor, Ind.	Westinghouse
38	1500	450/810	600	d-c	Geared	12-in. Finishing mill	Republic of Philippines	Philippine Islands	Westinghouse
39	1500	350/820	600	d-c	Geared	Cold aluminum strip	Aluminum Foils, Inc.	Jackson, Tenn.	Westinghouse
40	†1500	500	4000	50	Geared	Sheet finishing mill	Corporacion de Fomento la Producion	San Vicente, Chile	General Electric
41	2000	40/80	600	d-c	Direct	Hot aluminum strip	Aluminum Foils, Inc.	Jackson, Tenn.	Westinghouse
42	3000	90/260	600	d-c	Direct	56-in. Tandem mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
43	3000	80/240	750	d-c	Geared	Taper rolling mill	Aluminum Co. of America	Davenport, Iowa	General Electric
44	3500	150/320	600	d-c	Direct	48-in. Reversing cold strip mill	McLouth Steel Corp.	Detroit, Mich.	General Electric
45	3500	150/320	600	d-c	Direct	48-in. Reversing cold strip mill	McLouth Steel Corp.	Detroit, Mich.	General Electric
46	②5000	136/340	600	d-c	Direct	56-in. Tandem mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
47	②5000	212/477	600	d-c	Direct	56-in. Tandem mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
48	5250	255/637	600	d-c	Direct	56-in. Tandem mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
49	②7000	80/160	700	d-c	Direct	Universal structural mill	Inland Steel Co.	Indiana Harbor, Ind.	Westinghouse

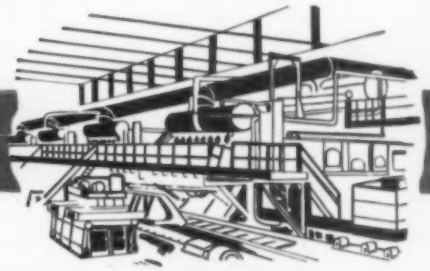
*Indicates synchronous motor †Indicates induction motor ①Indicates twin motor drive ②Indicates double armature

MOTOR RECAPITULATION

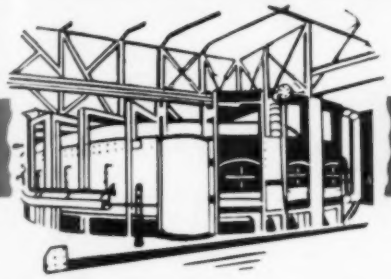
Company	Location	Type of mill	Number of motors	Total horsepower
Aluminum Co. of America	Davenport, Iowa	Taper rolling mill	1	3,000
Aluminum Foils, Inc.	Jackson, Tenn.	Aluminum cold strip mill	2	1,900
		Aluminum hot strip mill	1	2,000
Atlas Steels, Ltd.	Welland, Ontario, Canada	Sendzimir mill	1	1,250
Blair Strip Steel Co.	New Castle, Pa.	Tandem cold strip mill	1	500
Cold Metals Products Co.	Indianapolis, Ind.	Steckel mill	1	1,000
Copperweld Steel Co.	Warren, Ohio	12-in. Bar mill	1	800
Corporacion de Fomento la Producion	San Vicente, Chile	Sheet finishing mill	1	1,500
Fansteel Metallurgical Corp.	North Chicago, Ill.	26-in. Hot breakdown mill	1	600
Inland Steel Co.	Indiana Harbor, Ind.	Edging mill drive	1	1,400
		Universal structural mill	1	7,000
Kaiser Aluminum and Chemical Corp.	Permanente, Calif.	Aluminum foil mill	1	1,000
Kaiser Steel Corp.	Fontana, Calif.	86-in. Temper mill	2	1,000
Lukens Steel Co.	Coatesville, Pa.	Armor plate roller leveler	1	600
McLouth Steel Corp.	Detroit, Mich.	48-in. Reversing cold strip mill	6	11,800
National Steel of Brazil	Volta Redonda, Brazil	42-in. Temper mill	7	2,100
		Scale breaker	1	1,250
Phelps Dodge Corp.	Bayway, N. J.	Rod mill	2	800
Pittsburgh Steel Co.	Allenport, Pa.	4-Stand cold reduction mill reel	1	1,200
Republic of Philippines	Philippine Islands	18-in. Roughing mill	1	1,000
		12-in. Finishing mill	1	1,500
Seymour Manufacturing Co.	Seymour, Conn.	Sendzimir mill	1	400
United States Steel Corp.	Vandergrift, Pa.	Cold strip mill	3	3,750
Wheeling Steel Corp.	Benwood, W. Va.	Skelp mill	1	1,000
Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	56-in. Temper pass mill	4	4,000
		56-in. Tandem mill	5	19,450

Type of motors purchased	Number of motors	Total horsepower
Alternating current motors	8	7,200
Direct current motors	41	64,600
Total	49	71,800

Ask the men who operate them

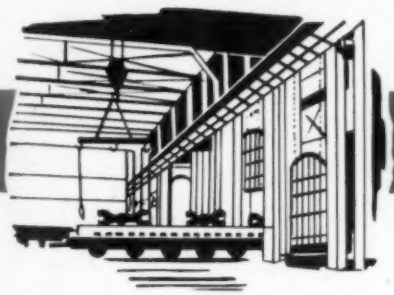


OPEN HEARTH · SLAB HEATING



ROTARY HEARTH · SOAKING PITS

ALL TYPES OF ANNEALING



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do a better job for every metallurgical heating need

"Efficient . . . economical . . . automatic . . . all fuels . . . easy to operate . . . trouble free . . ." Furnace men attest the dependability of all types of Rust furnaces serving metal making plants throughout the world. Patented zone-fired installations account for more than one-third of the heating capacity (excluding soaking pits) of America's iron and steel industry. Also in general use are many of the Company's soaking pits. Rust builds both regenerative and recuperative type pits. Whatever your need there's a type of Rust Furnace (individually designed) to do your job.

THE WHOLE JOB IS ONE JOB WITH A RUST "PACKAGE" CONTRACT

One contract covers everything . . . from blueprint through start up. Rust assumes responsibility for design, manufacture, erection, and is prepared to undertake all phases of the work with its own forces, including wiring and piping. This results in substantial savings . . . One profit instead of pyramiding ones which accrue where many subs are employed.

RUST FURNACE COMPANY

Pioneers in Furnace Design

RUST BUILDING **PITTSBURGH, PA.**

CRUCIBLE EXPANSION WELL UNDER WAY

▲ Crucible Steel Co. of America's new 1000 ton a day blast furnace started operation early in December. The blast furnace project, costing in the neighborhood of $12,000,000, increases Crucible's iron production by 60 per cent. The "blow-in" of the new furnace is the key development in Crucible's improvement and expansion program at Midland works. The new furnace, with 25-ft hearth diam, is capable of producing 1000 tons of metal a day. It is said to be the most modern automatically operated blast furnace in the United States. Everything can be "push button" operated except the actual tapping of the furnace. Auxiliary equipment consists of three Mohr type stoves, fully automatic stock bin area, air conditioned instrument house, an electrically controlled and air conditioned pump house and modern electric precipitator type gas cleaning equipment.

The additional iron from the new blast furnace will enable the company to increase open hearth production of steel. Construction of the new addition to the Midland Blast Furnace Department was started approximately 15 months ago.

FURNACE DETAILS

Crucible's massive new blast furnace rises 245 ft. The push of a single button triggers off a sequence of steps that sends "skip" cars loaded with tons of ore and coke alternately up and down a 215-ft incline to the top of the furnace. Stopping at a precise height the cars then automatically unload the iron-making ingredients, and a system using two bell compartments automatically drops these ingredients into the top of the furnace. For cooling, as much as 6,000,000 gal. of water a day are circulated through its elaborate cooling system.

At the "blowing-in" ceremonies, first "charge" consisted of 1277 tons, containing 644 tons of coke, 250 tons of ore, 297 tons of limestone and 86 tons of bessemer ladle slag.

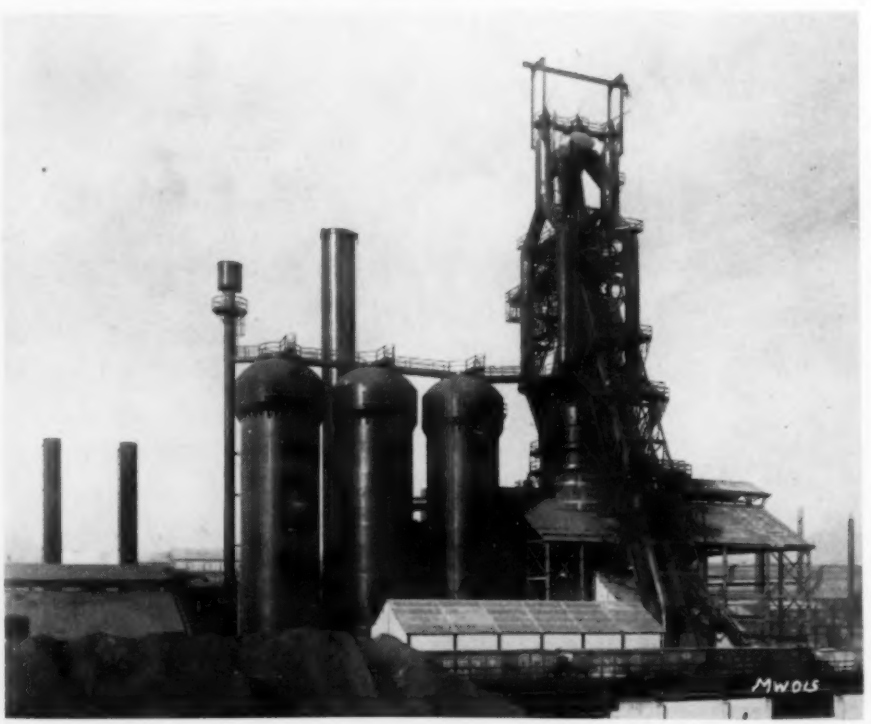
Turbo-blowers — A new DeLaval turbo-blower with a capacity of 75,000 cfm of wind at 30 psi pressure has been installed to furnish required air. This turbo-blower is equipped with a modern surface condenser.

Hoist control and instrument room— The heart and nerve center of the huge project is the hoist control and instrument house. An air-conditioned building, 100 ft long, 40 ft wide, and two stories high, contains the hoist controls, the electronic control instruments and the recording devices required for the automatic operation of the blast furnace. Also located here is an emergency push-button panel which can be used to charge the furnace (run the skip cars), and open and close the bells at the top of the furnace. This panel is a duplicate of the one regularly operated from the stock bin house.

Stock bin house — The stock bin area for Crubicle's No. 1 furnace has 48 of the latest type bins for ore and two more for coke. In the operation of the stock bin area the scale car operator loads ore, limestone or dolomite from the respective bins onto an Atlas rail car scale by pressing a button. These are then loaded into the skip car. For the coke loading operation the same master control board is used. The coke is loaded over a vibrating screen, shaking out the coke breeze or particles. The chunks of coke are then deposited on a Fairbanks-Morse weighing scale, weighed and then loaded into the skip cars.

Skip cars — The two skip cars carry an average load of seven or eight tons of solids to the top of the blast furnace. They ride on track up

Crucible Steel Co. of America's new $12,000,000 blast furnace is completely automatic and electronically controlled with the exception of one operation, that of tapping the flow of the molten metal.



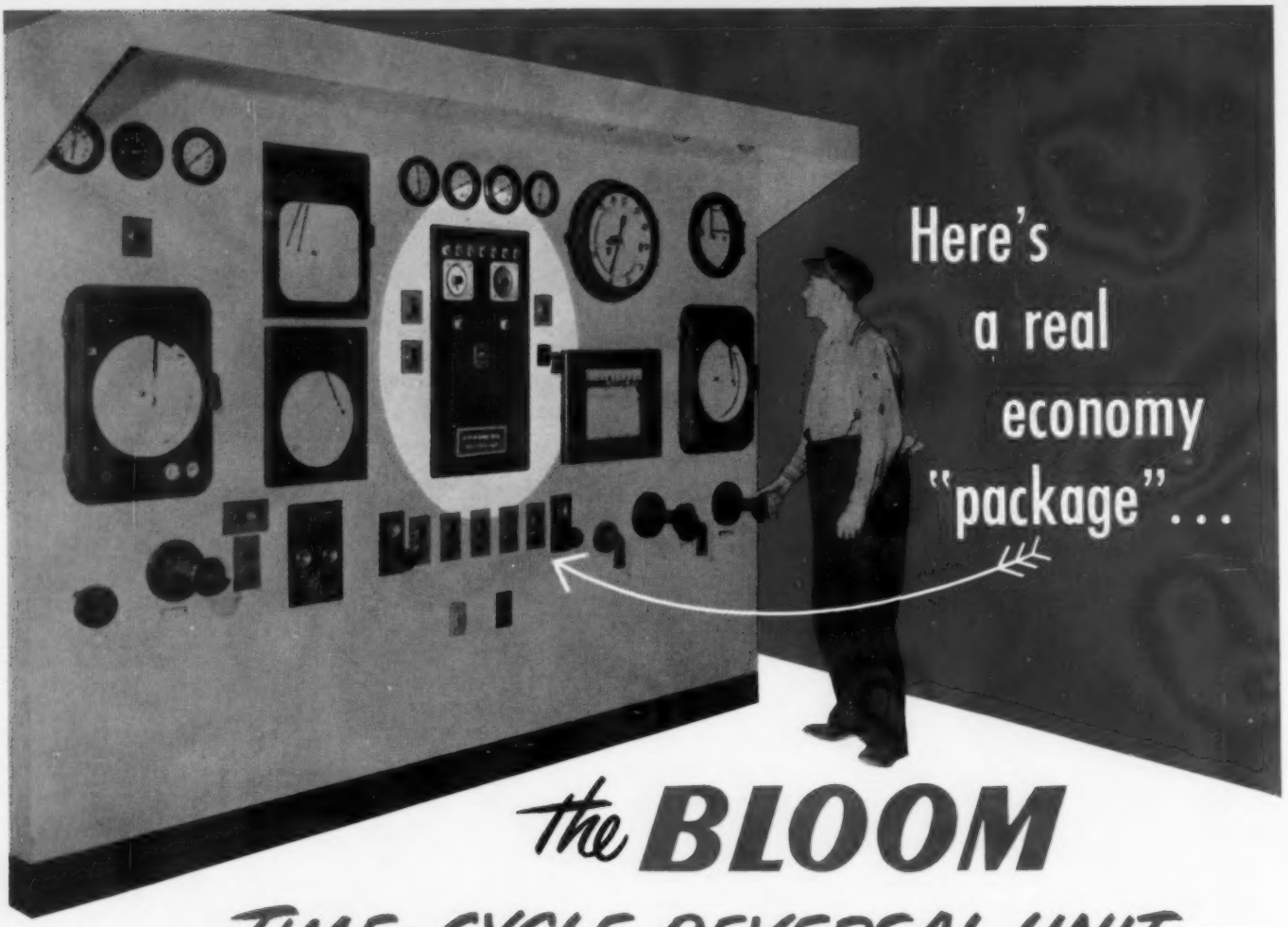
IT'S A BIG ORDER

...and we're grateful

Thanks to you, we've just completed a wonderful, successful year, our sixtieth. Naturally, we're proud of this proof that Hyatt Roller Bearings have earned the confidence of so many leading manufacturers of all kinds of equipment. In the year ahead we will have the advantage of enlarged plants and new, additional facilities to help us fill the continually expanding demand for Hyatt quality bearings. We're grateful for your valued business of the past year and will be looking forward to serving you again in 1953 along with many new Hyatt users. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey, Chicago, Detroit, Pittsburgh, Oakland, California.

HYATT

ROLLER BEARINGS



the BLOOM
TIME-CYCLE REVERSAL UNIT
for Open Hearths and Soaking Pits

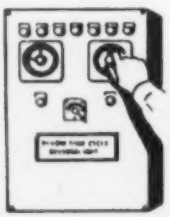
THIS factory-wired, compact, cabinet-enclosed unit keeps regenerative furnaces on a uniform reversing cycle without attention from the operator—yet the firing of the furnace can always be altered, or a quick reversal effected ahead of schedule if desired by a simple push-button control. Only nine or ten seconds are required to reverse the average furnace with this unit.

When the firing period for one end is completed, a sequence of operations begins in which fuel and steam are shut off, reversing dampers operate, and fuel and steam are admitted at the other end—all in a predetermined time-sequence that permits full and fast reversal without puffing or smoking. The Bloom Time-Cycle Reversal System is a specially engineered unit that includes: provision for operation by checker temperature as well as by time cycle, if desired; automatic "blow" and "hold" furnace operation; protection against excessive checker temperatures; full manual control of the reversal if demanded by the first helper.

We will be glad to send full information on this unit.

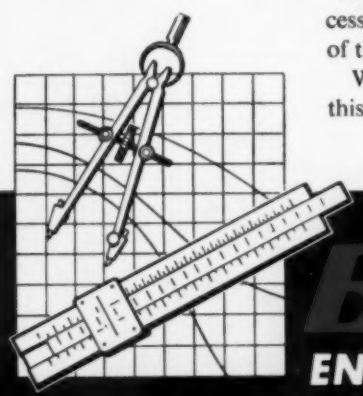
A complete, compact factory-wired and tested cabinet!

The field connections are easily and simply made—no complicated wiring is required. Each unit is completely factory-tested before shipment.



The reversal periods for both ends—North and South—are set independently, and can be changed at any time by a simple turn of the timer.

In case reversal is desired ahead of schedule, the operator merely pushes the reversal button. After reversal, furnace returns to original timing.



BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

a steep steel incline 215 ft long. At the top they automatically unload into a receiving hopper. From the receiving hopper the ingredients fall into the small bell throat. Then the load is dropped automatically onto the large bell. (From here the charge goes into the furnace.) The lowering of this large bell discharges the stock into the top of the furnace shaft.

Stoves — For pre-heating the blast or air which is sent under pressure into the No. 1 furnace, three Mohr stoves have been installed with a total of 630,000 sq ft of heating surface. The stoves are completely automatic and they feed the air heated to about 1000 F into the furnace in sequence — one of them heating the air going to the furnace while the brick in the other two is being heated up by burning blast furnace gas in them.

Dust catcher, gas washer, precipitators — Top gas is cleaned in a dust catcher, gas washer, and by the two large precipitators. The clean gas is then used in the heating of the stoves, in the boilers to make steam for the plant and to underfire the coke ovens.

A Dorr thickener removes the sludge from it prior to its recirculation.

Pump house — The new pump house contains eight DeLaval, electrically driven pumps, two low-pressure, three medium pressure and three high pressure.

MISCELLANEOUS

Crucible's No. 1 blast furnace is the third to be installed at Midland, basic steel producing plant of the company.

In addition to the turbo-blower installed for the new furnace, two Ingersoll-Rand turbo-blowers with a capacity of 60,000 cfm at 30 psi have been installed to improve the operation of the other two blast furnaces at Midland. The new battery of 29 coke ovens brings the number of ovens at Midland to 213 and increases annual coke capacity from 675,000 to 832,000 tons.

The electric furnace and open hearth departments have enlarged capacity to produce greater net tons per heat. Handling equipment in these two departments has been improved — new cranes, new ladles and a new ingot stripping crane. New soaking pits and auxiliaries will be completed before the end of this year.

A new 24-in. bar mill has begun operations. Equipped for both roughing and finishing operations, it consists of a reversing roughing stand and four stands of finishing mills with tables, saws and furnaces.

Overall expansion program is estimated at $40,000,000.

COOLER OPERATION
another reason why
OHIO is the PREMIER mill magnet
Morning . . . noon . . . night—Ohio Magnets lift efficiently, uniformly over extended periods of time because they operate cooler.
Take this husky Ohio Bolted Magnet. The heavy-duty copper strip coils are wound in longer lasting inorganic insulation and carefully sealed with plenty of non-cracking asphaltum.
For extra magnet life, extra magnet value—specify Ohio Magnets. And remember, Ohio Magnets lift as much or more than other magnets of the same size.
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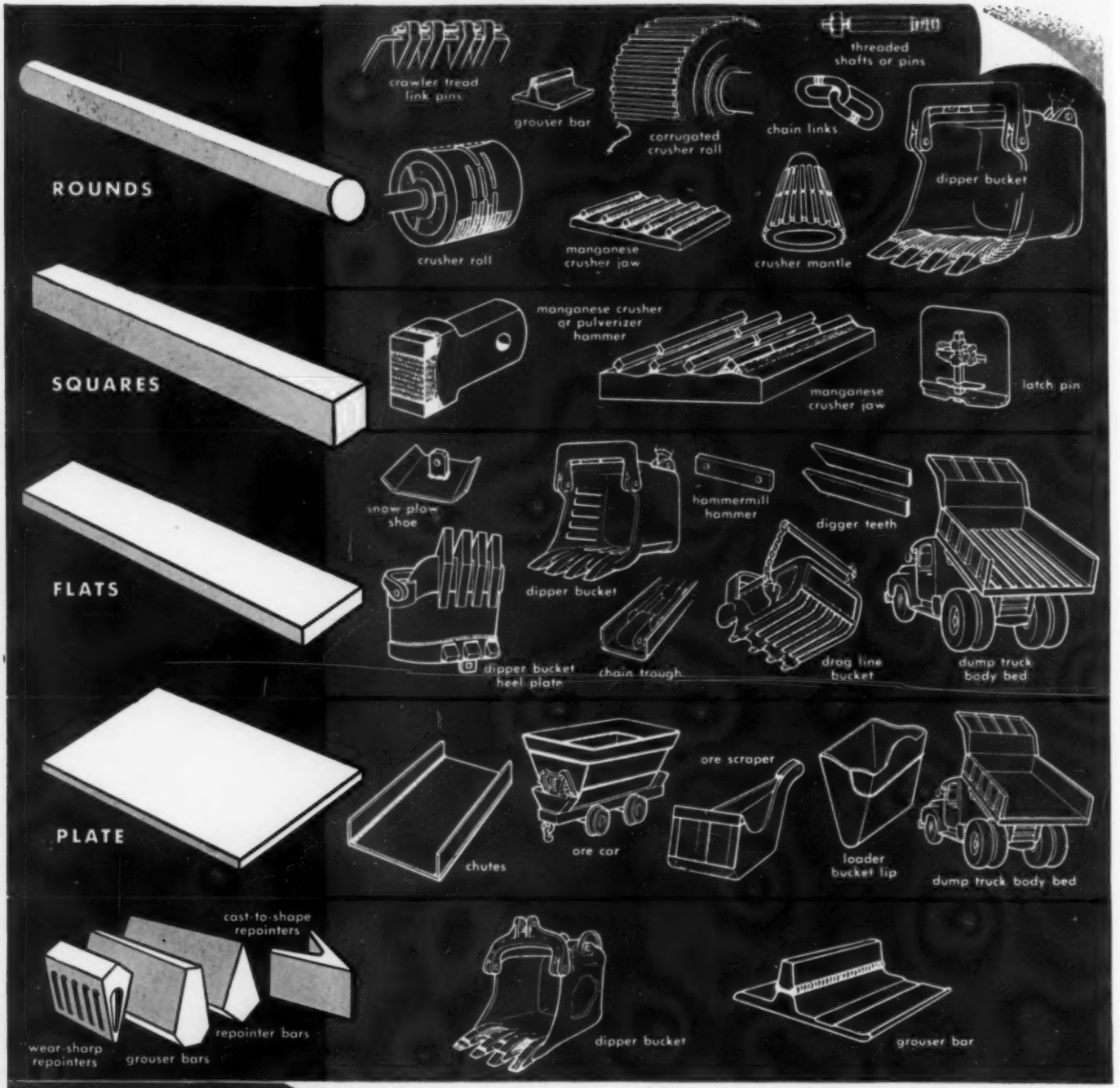
AMSCO MANGANESE STEEL WELDMENTS
ADD NEW LIFE TO WORN EQUIPMENT



Amsco Welding Rods and Electrodes For repair welding of manganese steel shapes to worn equipment, American Manganese Steel Electrodes retain their toughness and give real operating savings.

Amscoating with Amsco Hardfacing Rods increases service life . . . reduces shutdowns.

Contact your Amsco Distributor or write for illustrated catalog WA-77 on Amsco Manganese Steel Weldments and Hardfacing Selector Guide.

AMERICAN Brake Shoe COMPANY

AMERICAN MANGANESE STEEL DIVISION
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NO "DRESS REHEARSALS"
with
NATIONAL
TRADE-MARK
Carbon Brushes
for
Main Drive Motors and Generators

● "National" carbon brushes come to you time-tested for top performance all through the mill. And in big-time applications, like main drive motors and generators, this *finer quality* really pays off – may, in fact, become a vital factor in upholding full production.

● The more generally used grades and sizes of "National" carbon brushes for toe-to-toe and tandem-type holders have been *standardized* – a practice pioneered by NATIONAL CARBON to help concentrate research, development and manufacturing facilities *where they mean the most to you.*

● *Standardized* brushes are mass-produced under careful quality control. Always in stock for immediate delivery, they sell for the same low unit price regardless of quantity. Investigate these standardized brushes for *your* equipment before placing your next order.

NATIONAL STANDARDIZED BRUSHES
BETTER– PRODUCT–PACKAGE–PRICE– FASTER

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"Experience showed us how FUSETRON FUSES Prevent Motor Burnouts . . . now we protect all Motors on our Units with them!"

Franklin Van Reed
Production Engineering Supervisor
ORR & SEMBOWER, INC., Reading, Penn.

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Back in January of 1951 we had a motor on a pump that was supposed to draw a maximum load of about 8 amperes, yet it began blowing FUSETRON fuses of motor protection size.

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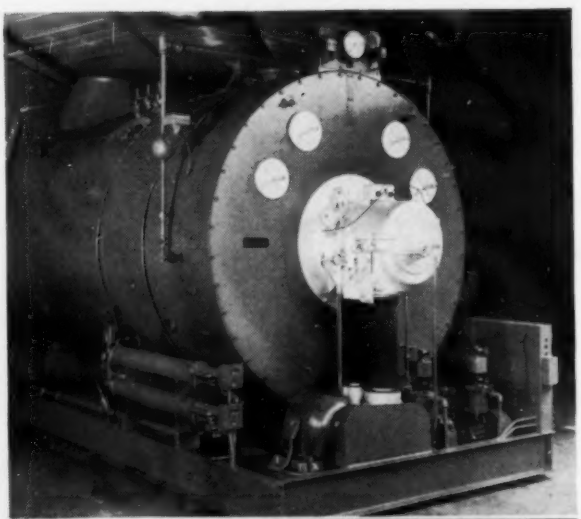
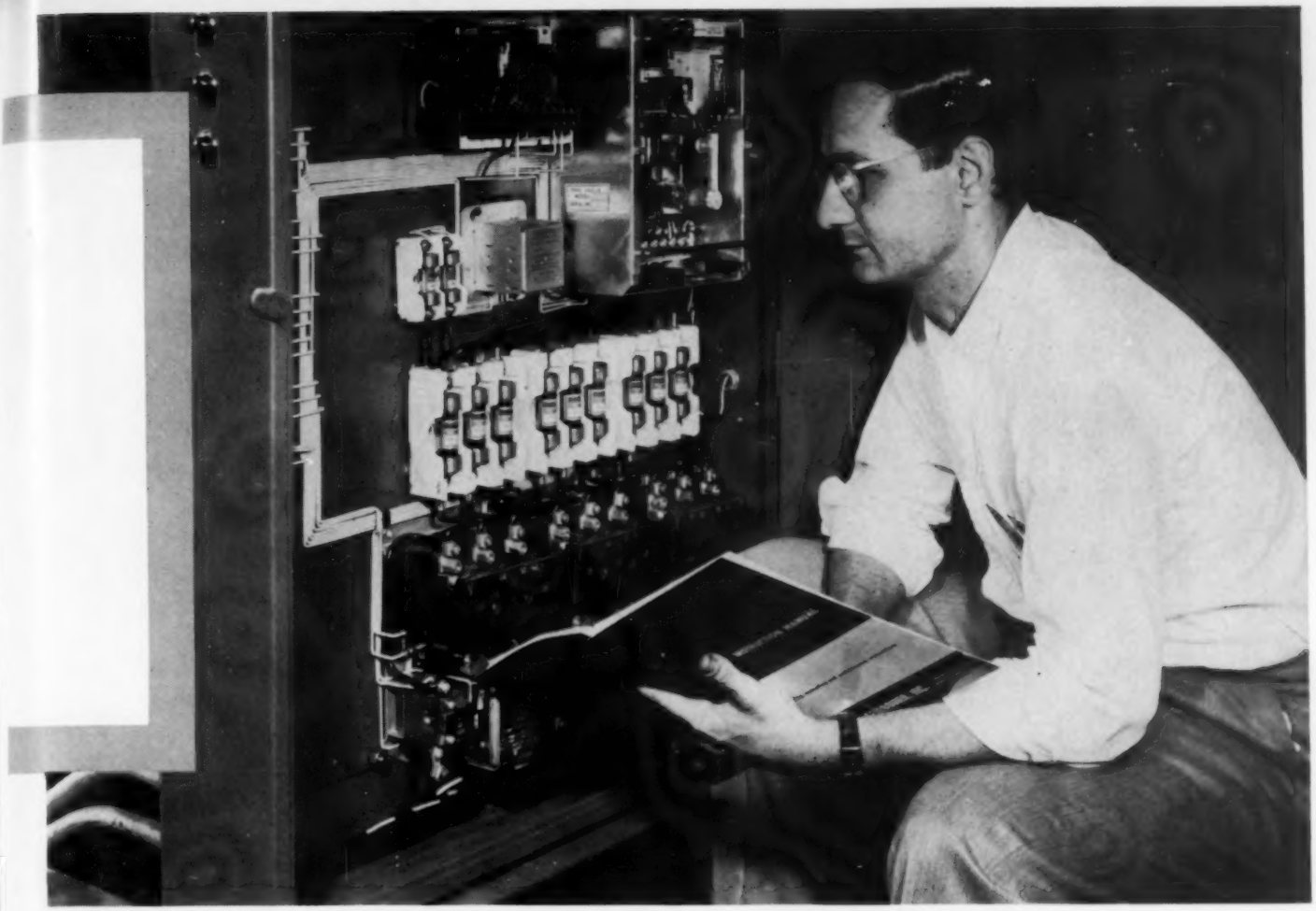
"If the Fusetron fuses had not opened, the motor would undoubtedly have burned out.

"Now on all our Powermaster Steam Generator Units we use Fusetron Fuses to protect the motors on the fuel pump, the boiler feedwater makeup pump, and the air compressor."

Franklin Van Reed
Production Engineering Supervisor
ORR & SEMBOWER, INC.,
Reading, Pennsylvania





You, too, can profit by the

10 POINT PROTECTION of Fusetron Dual-Element Fuses . . .

1 Protect against short-circuits.*
2 Protect against needless blows caused by harmless overloads.
3 Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.
4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.
5 Protect motors against burnout from overloading.
6 Protect motors against burnout due to single phasing.
7 Give DOUBLE burnout protection to large motors — without extra cost.
8 Make protection of small motors simple and inexpensive.
9 Protect against waste of space and money— permit use of proper size switches and panels.
10 Protect coils, transformers and solenoids against burnout.

*Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York City in December 1947.

FUSETRON is a trade mark of the Bussmann Mfg. Co., Division of McGraw Electric Co.

THE MONEY YOU SAVE . . . by preventing one **needless** shutdown, one **lost** motor, one **destroyed** switch or panel or one **burned out** solenoid . . . MAY MORE THAN PAY FOR the replacement of all your ordinary fuses with Fusetron dual-element Fuses.

THIS COUPON WILL BRING YOU complete information about the All-Purpose Protection of FUSETRON Dual-Element FUSES

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TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

Bussmann Mfg. Co., University at Jefferson, St. Louis 7, Mo. (Division of McGraw Electric Co.)

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OKOLITE-OKOPRENE ELECTRICAL CABLE...

proved in the steel industry for long, trouble-free service

Only a cable specifically built to withstand the heat, moisture, oils, acids and abrasive conditions in steel mills can be installed with confidence in mill power circuits. Okolite-Okoprene cables are built that way, and have been proved for power and control wiring in mills throughout the U. S.

Their basic electrical insulation is Okolite, the moisture-resisting rubber compound being used so successfully on 35,000 volt submarine cables. Their outer protection is tough Okoprene that won't rot or deteriorate. This neoprene sheath withstands high temperatures and is highly resistant to chemicals, oils, flame, mechanical damage, and any degree of moisture.

Both sheath and insulation, applied by Okonite's famed strip process, are bonded together during vulcanization in a metal mold. Only Okonite uses this precision method of manufacture in regular production.

To provide extra insurance against circuit outages, Okolite-Okoprene cables are shipped out only after passing the most severe a-c and d-c tests used in the industry.

Your Okonite representative can show you how Okolite-Okoprene cables will add years of service to your power circuits. Call him in today; or write for Bulletin IS-1053. The Okonite Company, Passaic, N. J.

The best cable is your best policy

OKONITE — SINCE 1878 — *insulated wires and cables*

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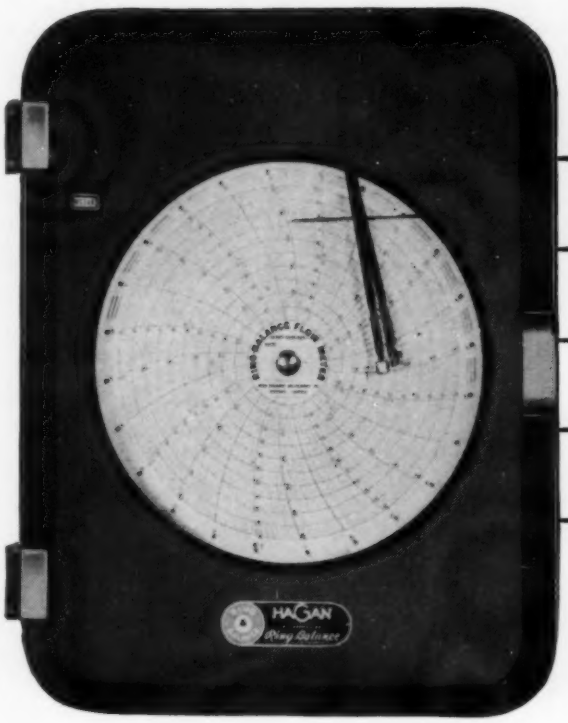
RING BALANCE FLOW METERS



This is the versatile Hagan Ring Balance Flow Meter

Models are available which will record, indicate and integrate two flows on a single chart. Standard modifications provide pressure and temperature compensation. Ring assemblies available can measure differentials from 1″ to 420″ water column maximum at static pressures up to 3,000 psig.

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- **Ease of dead weight calibration**
- **No stuffing boxes**
- **Mercury level not critical**
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HAGAN RING BALANCE METERS provide dependable, accurate flow measurement of oxygen, water, steam, gas, oil or other fluids. Design is simple, maintenance costs low.

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Over 1½ Miles of Buried Water Line Chemically Cleaned IN PLACE by Dowell Service

You don't have to dig up water lines in order to clean them! Take the case of a major railroad that had over 8600 feet of *buried* water lines, ranging from 2 to 12 inches in diameter. The capacity of these lines had been greatly reduced by scale deposits. Dowell Service used liquid solvents to clean all the lines, *in place*, during a period of only six days with a minimum interruption in service.

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FIND OUT ABOUT CHEMICAL CLEANING! There are many places in your plant where Dowell Service can clean equipment faster and better than out-dated mechanical methods. Call your nearest Dowell office for a fact-filled book. Or write direct to Tulsa, Dept. A29.

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Chemical Services for Oil, Gas and Water Wells

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Tulsa 1, Oklahoma

Look to **DOWELL**

FOR OIL INDUSTRY CHEMICAL SERVICE

Date-line Diary...

December 1

▲ Based on reports from companies having 93 per cent the capacity of the industry, the operating rate of the steel industry for the week beginning December 1, 1952 is scheduled at 105.5 per cent of capacity. This is equivalent to 2,191,000 tons of steel ingots and castings compared with 2,203,000 tons one week ago.

December 2

▲ The Commerce Department reported manufacturers' sales in October rose to $26,200,000,000 compared with $24,300,000,000 for the same period one year ago, or the highest in history. Bookings of new orders by manufacturing firms reached $25,900,000,000 or 3 per cent higher than September.

December 4

▲ Defense Mobilizer Fowler stated that existing controls on prices, wages and materials will stay in force as long as the Truman Administration is in power, and rejected the steel industry's decontrol plan, which would have given civilian goods producers almost free access to steel supplies by April 1, 1953. However, extra rations of steel will be permitted users in the first quarter.

▲ The OPS authorized a retroactive increase of 10¢ a ton in Great Lakes iron ore carriers rate ceilings, which applies to the period between the end of the strike on July 26 and December 31.

December 5

▲ Chairman of the Wage Stabilization Board Archibald Cox resigned in protest of President Truman's approval of the $1.90 daily pay increase for the United Mine Workers.

December 6

▲ A $1,000,000,000 defense buying program abroad is being started by the United States, and approximately $225,000,000 of the total will be used to purchase foreign aircraft. Government officials said the initial contracts will involve $90,000,000, which will cover production of Britain's "Centurion" tank.

▲ The Commerce and Labor Departments announced construction expenditures in the first eleven months of 1952 rose to $29,800,000,000, or 5 per cent above a year ago. It is predicted by these two federal agencies that the year's outlay will reach $32,300,000,000 and the 1953 total will be about $33,500,000,000.

December 8

▲ According to the American Railway Car Institute, November deliveries of domestic freight cars amounted to 5929 compared with 5437 for October. New freight cars on order in November totaled 2878 and backlog of cars on order as of December 1 was 87,657.

▲ Based on reports from companies having 93 per cent of capacity for the steel industry, the operating rate for the week beginning December 8, 1952 is scheduled at 105.5 per cent of capacity. This is equivalent to 2,191,000 tons of ingots and castings compared with 2,180,000 tons one week ago.

December 9

▲ A 28 per cent increase in its cobalt expansion program has been announced by the Government. A new goal was set by the DPA to increase U. S. supplies of the metal to 27,000,000 lb in 1955.

December 10

▲ T. Takasaki, president of Aetna Japan Co., and Electric Power Development Co. of Tokyo outlined preliminary plans for a new $100,000,000 steel mill in India to be owned jointly by the Japanese and Indian governments. If approval is granted by the respective governments, the next step would be application for a World Bank loan.

▲ The Commerce Department reported that business inventories climbed to $74,400,000,000 at the end of October, up $324,000,000 from a year ago.

▲ For the first eleven months of 1952, dividend payments by United States corporations totaled $6,500,000,000, or a 3 per cent increase for the same 1951 period.

▲ The Aluminum Association reports that production of primary aluminum in October was 154,624,138 lb compared with September's 153,764,606 lb. Total October shipments of aluminum sheet and plate were 105,962,651 lb compared with 94,442,980 lb in September.

December 11

▲ In the fiscal year starting July 1, 1953, the Army announced it will start to slow down output of medium and light tanks, and military trucks. Thus 55 per cent fewer medium tanks than originally planned will be on hand by early 1954.

▲ The Colorado Fuel and Iron Corp. expects to provide over $6,000,000 by selling publicly 340,000 shares of its common stock, to help its subsidiary Colorado Steel Corp. purchase J. A. Roebling's Sons Co.

▲ The AISI reported that steelmaking furnaces in the United States produced 9,446,000 tons of ingots and castings in November (largest ever for that month).

December 12

▲ At a recent press conference, President Truman expressed his determination to keep wage and price controls in effect and urged that they be extended beyond April 30 scheduled expiration date.

December 15

▲ Based on reports from companies having 93 per cent capacity of the steel industry, the operating rate for the week beginning December 15, 1952 is scheduled at 105.7 per cent of capacity. This is equivalent to 2,196,000 tons of steel ingots and castings compared with 2,207,000 tons one week ago.

▲ Because of changes in the cost-of-living price index, wage contracts of several million workers will have to be renegotiated early in 1953 according to the Labor Department.

December 16

▲ An additional $12,000,000 of steelmaking facilities in Ashland, Ky. has been authorized by Armco Steel Corp., and construction of the new units is scheduled to begin as soon as engineering plans are completed and necessary machinery purchased.

December 17

▲ President Truman has named Michael DiSalle, Economic Stabilizer to succeed Roger L. Putnam.

▲ M. A. Follansbee, president of Follansbee Steel Corp., stated that the company plans to spend $34,000,000 to build facilities for manufacturing its own hot rolled steel, and applied to the RFC for a $29,500,000 loan.

December 18

▲ In the second quarter of 1953, civilian goods producers will be allocated 70 per cent of the amounts

of steel they used before Korea. The DPA granted auto companies enough steel, copper and aluminum to build 1,250,000 cars in the second quarter of 1953, but will have permission to build 1,500,000 cars in the same period if they are able to secure the extra materials.

▲ The OPS gave International Nickel Co., Inc. permission to raise prices of monel, inconel and nickel mill products 2½¢ a lb at its Huntington, W. Va. plant.

▲ The Bureau of Labor Statistics reported that factory employment in November rose 36,000 from October to a total of 16,529,000, which is the highest since World War II.

December 19

▲ Auto makers and other civilian goods manufacturers were doled out an additional 550,000 tons of steel sheet and strip by the government for use in the first quarter of 1953. Of this, auto companies received 353,000 tons.

▲ The Commerce Department reported that October shipments of U. S. goods abroad declined for the fifth straight month. Commercial exports for the first ten months of 1952 were $285,000,000 less than for the same period in 1951, and imports for this period were off $500,000,000 from 1951

▲ Subject to shareholders' approval at the annual meeting on April 16, directors of the Aluminum Co. of America voted to split the common stock on a two-for-one basis.

December 20

▲ According to the AISI, finished steel in October was 7,155,611 net tons, or 614,000 tons more than in September, and 312,000 tons more than in October of the previous year. For the first ten months of 1952, shipments of steel amounted to 54,244,615 net tons, or 11,700,000 tons less than the same period one year ago, reflecting loss of production due to the steel strike.

▲ British Iron & Steel Corp. approved application of Steel Co. of Wales to spend $112,000,000 on erection of 5-stand cold reduction mill. Machinery will probably come from U. S.

▲ The Indian Iron & Steel Co., Ltd. of West Bengal received a loan of $31,500,000 from the International Bank for Reconstruction and Development for the expansion of iron and steel production in India. This is the first loan the World Bank made directly to a manufacturer. The loan is guaranteed by the government of India.

December 21

▲ According to the Bureau of Mines, United States Department of the Interior the consumption of ferrous materials during September increased 612,463 gross tons over the previous month. Purchased scrap consumption totaled 2,862,994 gross tons or an increase of 124,401 tons over the previous month. Iron ore production during September reached a record high of 15,912,165 gross tons, or 80,000 tons more than in August. Consumer's stocks of ore and sinter were 43,568,582 gross tons, 82 per cent of which were held in Illinois, Indiana, New York, Ohio, and Pennsylvania.

December 22

▲ Based on reports of companies having 93 per cent capacity for the steel industry, the operating rate for the week beginning December 22nd is scheduled at 103.1 per cent of capacity. This is equivalent to 2,141,000 tons of ingots and castings compared with 2,236,000 tons last week, the highest production in any one week.

▲ Mr. George Meany, president American Federation of Labor, stated the federation will now settle for less than an out-right repeal of the Taft-Hartley Act. Secretary of Labor designate Martin P. Durkin will seek agreement between labor, management and Republican leaders for changes in the Taft-Hartley law.

▲ The NPA reported that at the end of October, steel scrap inventories of mills averaged more than a 60-day supply. More scrap will be needed in 1953 to maintain the high rate of ingot production.

▲ It was announced today that on December 31, 1952 at midnight, the corporate structure of United States Steel Co. will be merged into the United States Steel Corp.

December 23

▲ The price of lead rose ¼¢ to 14¼¢ a lb in New York.

▲ According to the AISC, November shipments of fabricated structural steel amounted to 222,594 tons, or slightly higher than the same month in 1951. Bookings during November were 143,454 tons, a 22 per cent decrease from October. The backlog of work as of November 30 stands at 2,357,351 tons.

December 24

▲ The AISI reported the monthly payroll in October for the entire iron and steel industry is estimated at $282,896,000, or $13,500,000 higher than September. Employment in the industry is estimated at 676,800. Wage earners worked an average of 41.8 hours a week in October, and average hourly earnings were $2.161.

▲ The Commerce Department reported that civilian employment in November was 62,200,000.

▲ According to preliminary reports of the AISC, total shipments of fabricated structural steel for 1952 were 2,615,000 tons, compared with 2,702,000 tons in 1951.

December 25

▲ Merry Christmas!

December 26

▲ Through an exchange of stock, directors of Harrisburg Steel Co. have approved a merger with Heckett Engineering, Inc. of Butler, Pa. A meeting of the Harrisburg Steel stockholders will be held March 17 at which time the merger is subject to ratification.

December 29

▲ The Securities and Exchange Commission predicted business outlays for new plants and equipment for 1953 will reach $26,300,000,000 compared with the record $26,900,000,000 for 1952.

▲ Based on reports from companies having 93 per cent capacity for the steel industry, the operating rate for the week beginning December 29 is scheduled at 106.9 per cent of capacity. This is equivalent to 2,220,000 tons of steel ingots and castings compared with 2,133,000 tons one week ago.

December 30

▲ The price of lead rose another ¼¢ to 14½¢ a lb in New York.

December 31

▲ For the second quarter of 1953, structural steel allotments for military and civilian use were set at 1,692,000 tons.

▲ Defense Mobilizer Fowler's proposal that major producers make a five-year contract to deliver aluminum to Government stockpiles was rejected by the Aluminum Co. of America.

▲ The price of lead increased ¼¢ a lb to 14¾¢ in New York.

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No need to let delayed deliveries of new steel plant equipment stall your production schedules. We can supply good used equipment . . . NOW . . . at substantial savings in cost! We also provide dependable service on engineering and installation of accessories. It pays to *Call Curry* for complete rolling mills, motors, press brakes, roll grinders, ladles, cranes and other equipment you need *in a hurry*. Check the partial list of equipment below—available for immediate delivery. Write, wire, or phone today for the complete "Curry List" of equipment we now have which may answer your requirements.

2½" & 20" x 7½" REVERSING COLD REDUCTION STECKEL MILL, complete with Recoiling Equipment, Main Drive Motor, Motor-Generator Set, Controls and Spare Parts.

2000 H.P., G.E. SLIP RING MILL TYPE MOTOR, 3/60/2300 v 237 RPM, complete with Liquid Slip Regulator and all controls necessary for mill type operation, including Filtered Air Cooling System.

75-TON MORGAN LADLE CRANE. WITH 25-TON AUXILIARY. 4-Girder Construction. Span 49'6". Motors & Controls for 230v. DC operation.

18"/21" 3-HIGH BAR MILL, complete with Pinion Stand, Gear Reduction Unit, 2500 H.P. Motor, Billet Heating Furnace, Tables and Electric Equipment.

500 H.P. FALK GEAR REDUCTION UNIT. Ratio 18.6 to 1, for 31 RPM output.

80" HYDRAULIC STRETCHER LEVELLER, Capacity 80" wide x 200" long, complete with all Hydraulic Pumps, Controls, and Motor.

400 H.P. GEAR REDUCTION UNIT (WESTINGHOUSE), Single Reduction, Helical Gears, Ratio 6 to 1.

600 H. P. GEAR REDUCTION UNIT (FARREL-BIRMINGHAM), Ratio 2.95 to 1, Single Reduction, Rebuilt 1950.

300 H.P. GEAR REDUCTION UNIT (LEWIS FOUNDRY & MACHINE CO.), Ratio 13.5 to 1, Double Reduction.

156" x ¼" UNITED ENGINEERING & FOUNDRY COMPANY, Power Squaring Shear arranged for 10 H.P. motor, 26 cuts/min.

PORTABLE ALLIGATOR CROP SHEAR 7½" Knives, Reconditioned.

D & K No. 2 ALLIGATOR SHEAR, 21" Knives, 7½ H.P. 3/60/220-440V Motor.

5 TON OVERHEAD ELECTRIC CRANE, 47' Span D.C. Cab Operated.

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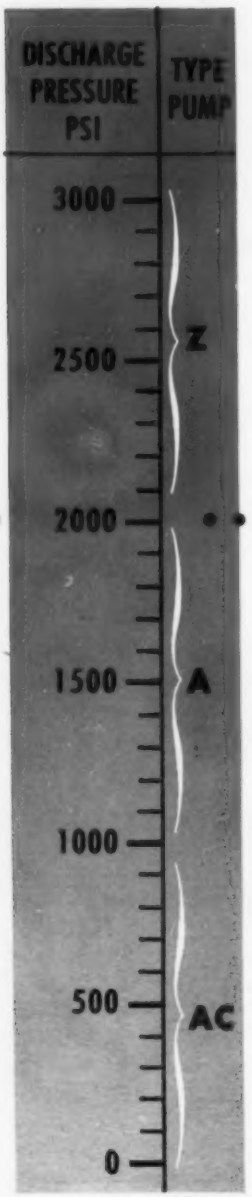

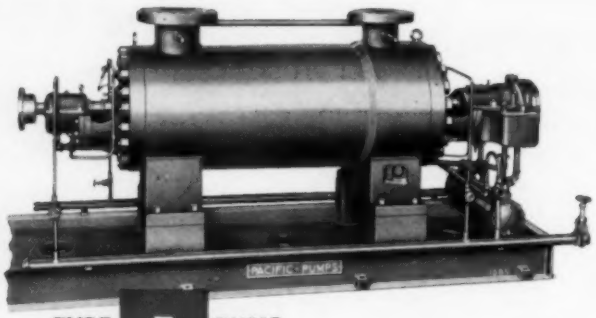

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Sizes 2" to 8" Capacities 100 to 2700 GPM.

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IMPELLERS—Carbon Steel, Bronze or Chrome Alloy Steel.

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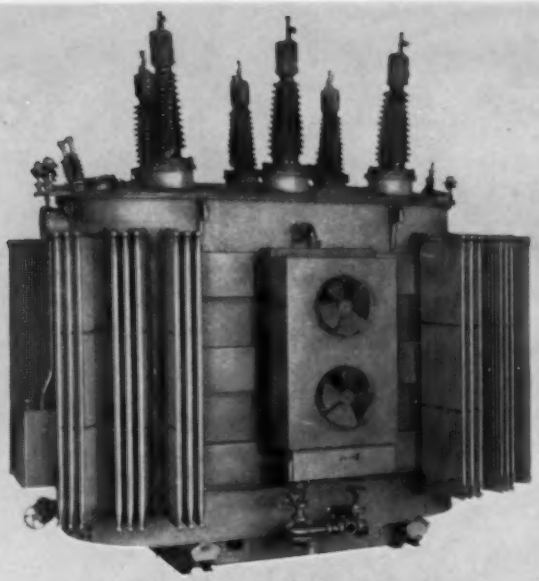
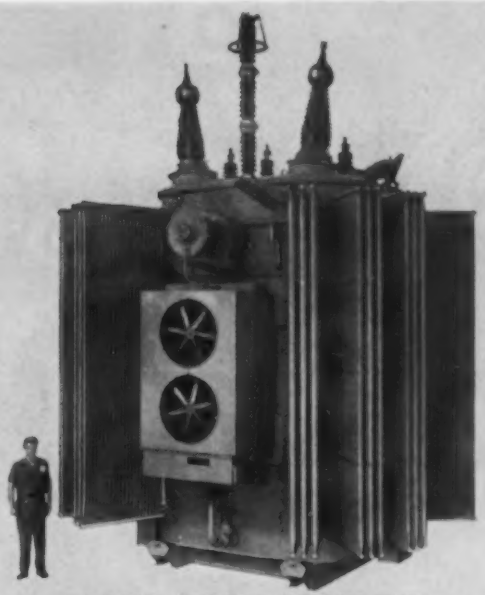
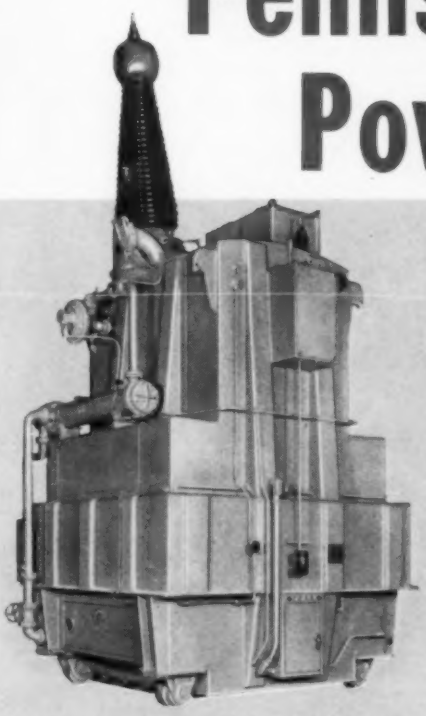


36,000/48,000/60,000 KVA
Auto Transformer. Three-phase, 60 Cycles, 55°C. Rise. 138,000 Grd. Y —115,000 Grd. Y—13,800△ volts.



25,000/33,333/41,667 KVA
Single-phase, 60 Cycles, 55°C. Rise. 110,000—7950/13,800 volts.

Pennsylvania Oil-filled Power Transformers



29,000 KVA
Single-phase, 60 Cycles, 55°C. Rise. 230,000 Grd. Y/132,800 —13,200 volts.

According to NEMA Standards, oil-filled transformers can be cooled in nine different ways. The manner of cooling depends upon many considerations, such as the operating characteristics of transformers using various types of cooling; the availability of large quantities of water; and what is very important, the economics of selecting one type of transformer over another.

The latter consideration may require some study. Auxiliary cooling methods applied to a self-cooled transformer can add, at relatively low cost, as much as 66⅔% additional capacity to the transformer. On the other hand, the efficiency of the transformer and the cost of operating certain types of cooling equipment may be more important considerations than the initial lower cost of a forced-cooled transformer. These are matters that can best be discussed between the engineers who specify a transformer and the engineers who design the transformer.

Pennsylvania Transformer Company manufactures transformers of every standard classification and with every type of cooling equipment. If you have a problem in cooling, or for that matter, if you have any transformer problem, you are invited to utilize the experience of Pennsylvania's Engineering Department.

Write for free copy of booklet No. 522 entitled "Economics of Transformer Cooling." This booklet explains the various methods of cooling transformers and discusses their advantages and disadvantages.

PENNSYLVANIA TRANSFORMER COMPANY
A McGRAW ELECTRIC COMPANY DIVISION
CANONSBURG, PA. • *Greater Pittsburgh District*

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CINDER CARS

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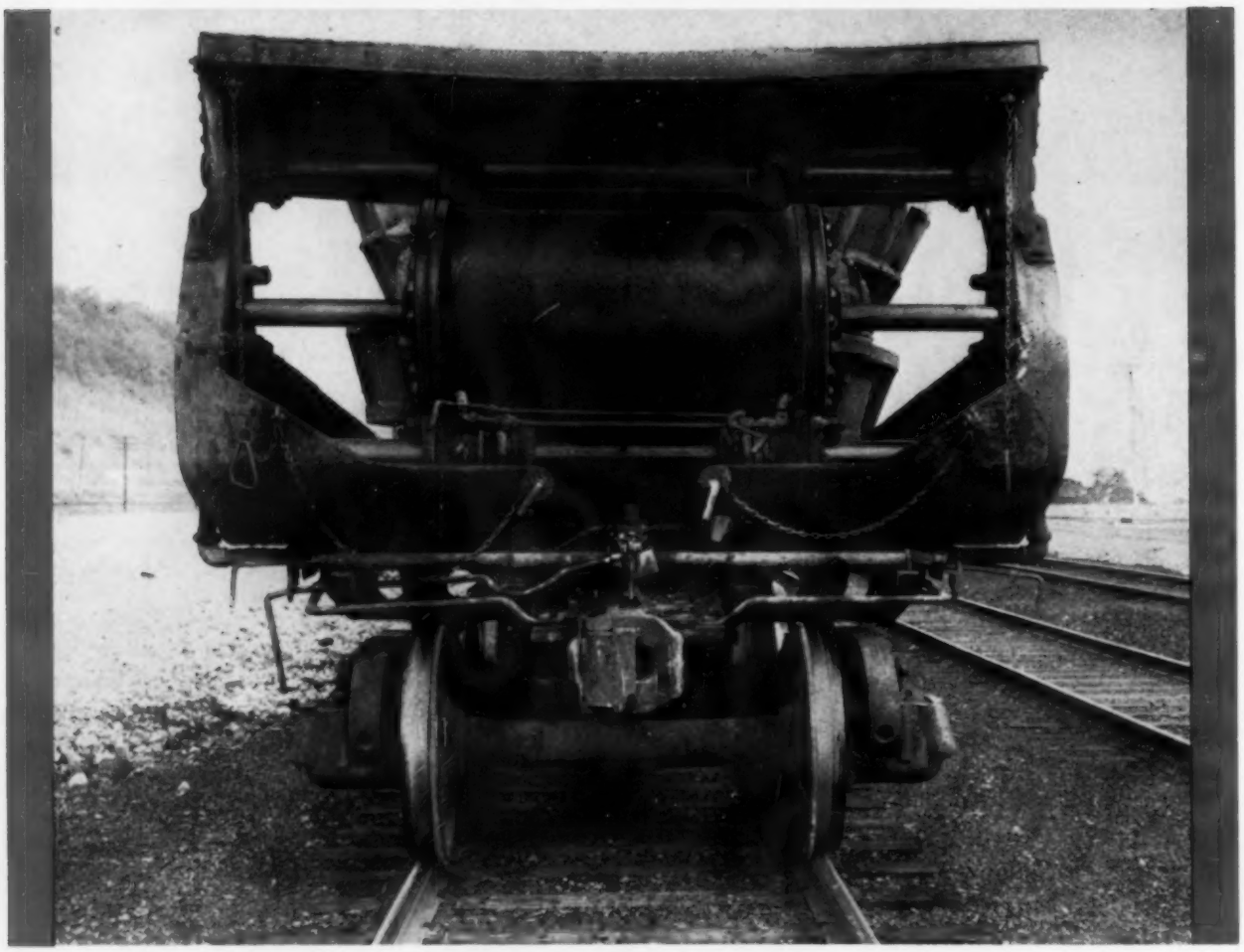

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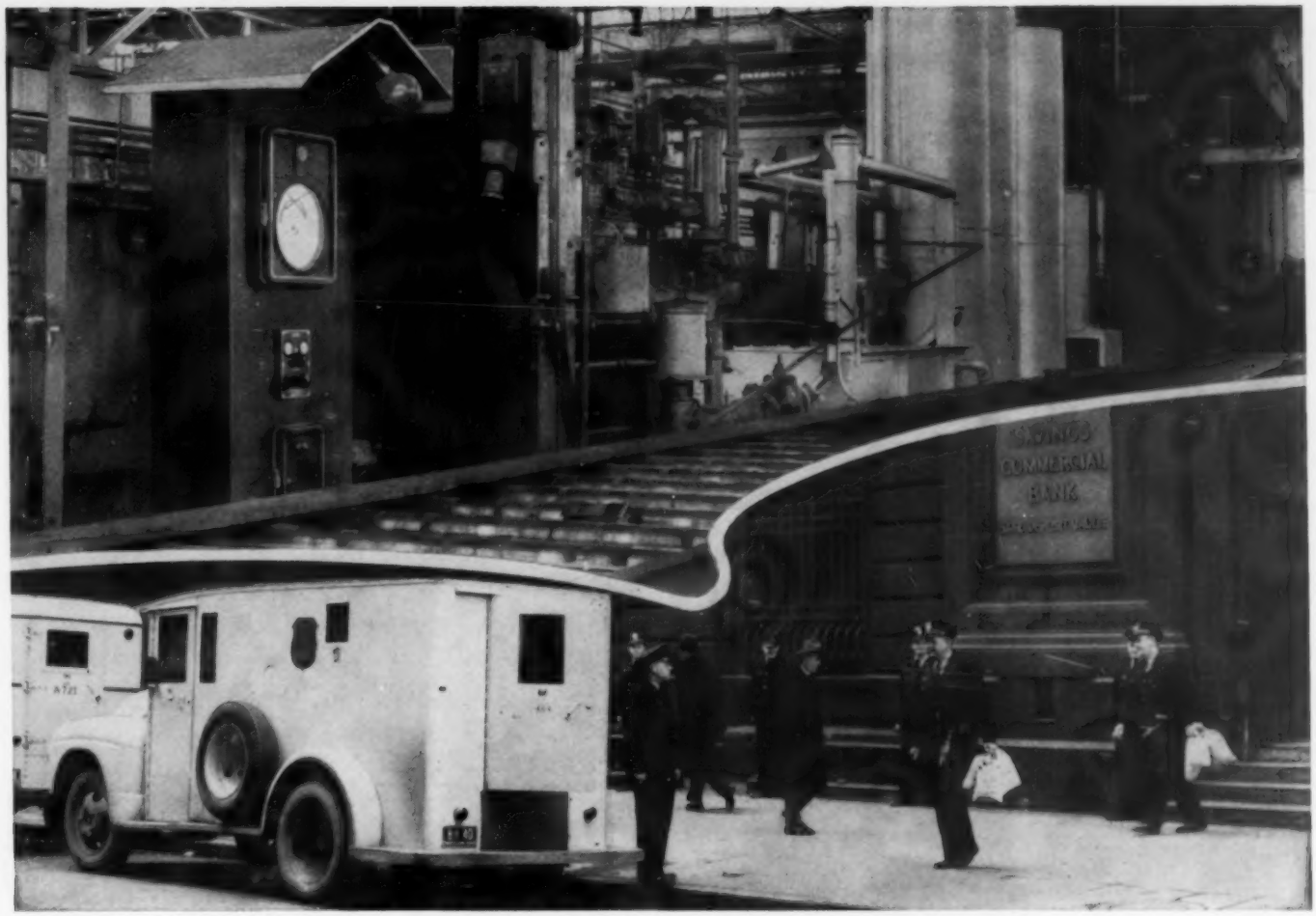

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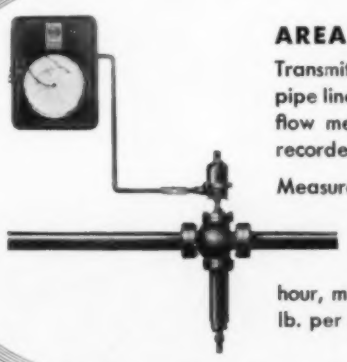
HERE'S HOW TO PREVENT SPOILAGE AND WASTE . . .

TO avoid waste of valuable process materials and finished products, process rates and conditions must be accurately measured and controlled. That's where Bailey Meters, Analyzers and Controllers can help you to improve the efficiency of your plant.

Take flow for instance. Bailey Meter Company offers a complete line of flow measuring and controlling equipment for applications ranging all the way from high pressure steam to low pressure gas. We measure flow in pipes, open channels, ducts, furnaces, smelters, kilns, ovens, dryers.

When you call Bailey Meter Company, you get the help of years of experience as well as recommendations from a wide selection of measuring and controlling devices.

Your local Bailey Engineer is as near as your telephone. He has the experience and the equipment necessary to set up an effective guard for your process materials. P-26



AREA TYPE FLOW METER

Transmitter goes into 1, 2 or 4 inch pipe line like a valve and transmits flow measurements electrically to recorder in remote location.

Measures oil and other clear liquids under static pressures up to 600 psi. Minimum range 0 to 1200 lb. per hour, maximum range 0 to 9600 lb. per hour.

BAILEY METERS

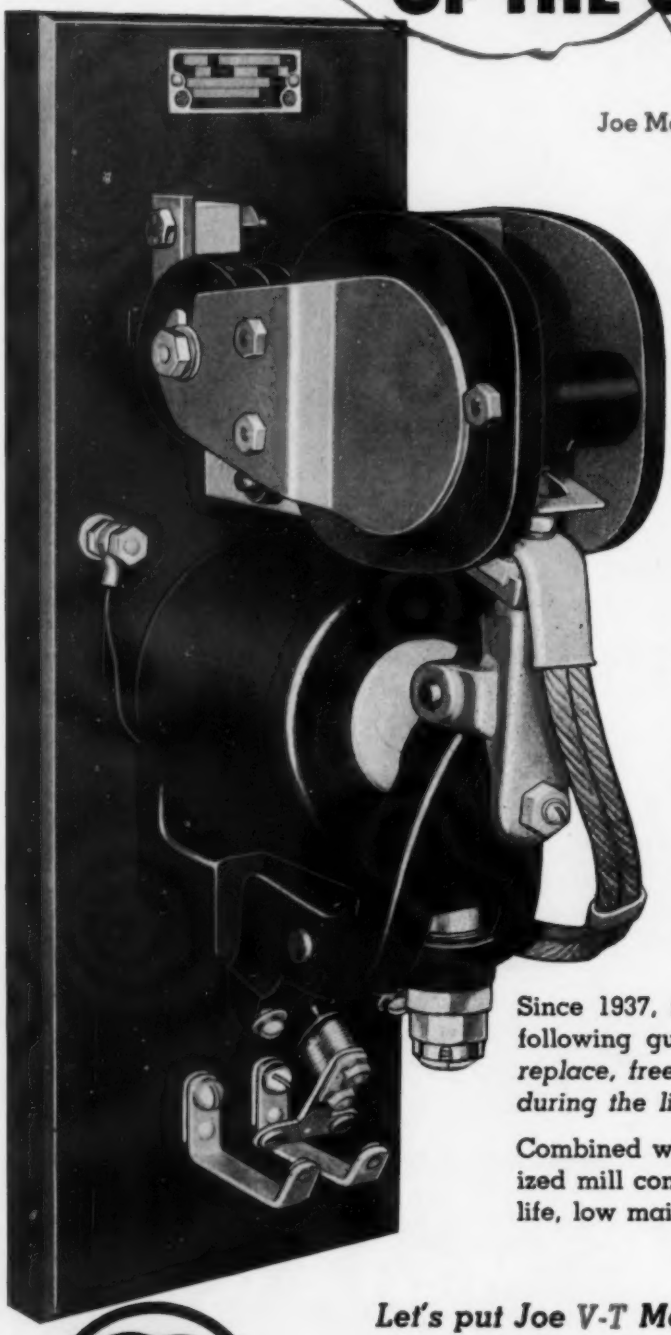
BAILEY METER COMPANY

1047 IVANHOE ROAD
CLEVELAND 10, OHIO

Process Controls

TEMPERATURE · FLOW
PRESSURE · LEVEL
GAS ANALYSIS · RATIO

MEET THE *Joe Magaric* OF THE CONTROL INDUSTRY!



Joe Magaric is the legendary giant of the Steel Industry. He was a fiend for work. In the old country "MAGARIC" meant "MULE"—a good name for Joe. He had the endurance of a mule, and the workhorse ability of one too. His fabulous and incredible activities made him the symbol of power, strength, and high production.

Joe Magaric of the Electrical Control industry is no myth. In countless thousands of applications in mills all over the world, CLARK VARI-TIME CONTACTORS are making records comparable to feats of Joe Magaric.

There are records of millions of operations in the steady 24 hour per day grinds in mills, records of continuous runs in processing lines, records of taking the slam-bang of cranes, open hearth chargers, records in all phases of mill operation, with no downtime—no maintenance. For nearly a quarter of a century the CLARK V-T contactor has been the Joe Magaric of the Electrical Control field. Why is this?

The Joe V-T Magaric Contactor incorporates a hermetically sealed timing device within itself, thus providing a pre-set adjustable time delay before it closes. This eliminates separate timing relays and simplifies wiring.

Since 1937, this hermetically sealed core has carried the following guarantee—*"The Clark Controller Company will replace, free of charge, any core which will fail in service during the lifetime of the controller."*

Combined with other CLARK apparatus and CLARK specialized mill control engineering, Joe V-T Magaric provides long life, low maintenance service.

Let's put Joe V-T Magaric to work for you.

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO

TNEMEC PRIMERS KILL RUST!

SMALL amounts of moisture will inevitably penetrate any paint film, causing rust and corrosion . . . but TNEMEC *uses* this moisture to destroy rust at its source!

TNEMEC PIGMENT is a compound which includes and intensifies the preservative properties of Portland cement. Combined with moisture, it creates a neutral condition on steel surfaces, changing active rust and corrosive agents into an inactive neutral compound.

That's the amazingly simple process that makes TNEMEC so outstandingly successful as a prime coat on steel. We invite you to investigate the performance of TNEMEC Primers on any type of installation . . . for adhesion, waterproofness and durability . . . under the most severe conditions. Its record as a long-lasting, anti-corrosive coating is unique.

Ask Any TNEMEC User
(TEE-NEE-MIK)

SEE OUR CATALOG IN SWEET'S

MAIL THIS COUPON FOR YOUR COPY OF TNEMEC CATALOG 50

TNEMEC COMPANY, INC.

TNEMEC COMPANY, INC.
131 W. 23rd Ave., North Kansas City, Missouri

Gentlemen:
Send my copy of your Catalog 50 to:

NAME _____

FIRM NAME _____

ADDRESS _____

CITY _____ ZONE ___ STATE _____

JOY Plugs and Receptacles . . .

Industry's favorite electrical connectors

The most convincing sellers of JOY plugs and receptacles for Industrial applications are JOY plugs and receptacles themselves. Records prove that the initial installation in a Steel Mill, Scrap yard or Foundry invariably leads to widespread usage on many different types of mobile and stationary equipment.

Molded as one-piece Neoprene units, JOY connectors can't crack or smash out of shape when dropped — won't become mushy when smeared with grease or oil — and are absolutely moisture tight. Cork-like action of their water-seal also prevents metallic dust from accumulating around contacts.

Why accept less when the best actually costs less in the long run? For proof give us a brief description of your current needs. We'll welcome the opportunity of recommending the right JOY connectors to solve them . . . without obligation.

BULLETIN B41

THIS NEW BULLETIN IS YOURS . . . FOR THE ASKING

Our supply on this attractive new three color bulletin is adequate . . . *we had an extra large quantity printed* . . . however why not ask for your copy before it slips your mind? By doing so you'll be sure to have up-to-date reference material on JOY'S products at hand the next time you need good electrical connectors.

M.E. 153.5

Consult a Joy Engineer

JOY MANUFACTURING COMPANY

HENRY W. OLIVER BUILDING, PITTSBURGH 22, PENNSYLVANIA

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LTD., GALT, ONTARIO

COOLING BED?

no...this is a Cooling Bed

. . . very good example of the ability of Morgan engineers to come up with the answer to a rolling mill problem. It continuously cools in straight lengths a variety of rolled steel products. It is simple, accurate and requires a minimum of maintenance.

What is your rolling mill problem? May we give you a hand?

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

English Rep., International Construction Co., 56 Kingsway, London W. C. 2, England

ROLLING MILLS • MORGOIL BEARINGS • WIRE DRAWING MACHINES
REGENERATIVE FURNACE CONTROLS • EJECTORS • GAS PRODUCERS

RM-94

OVERHOISTING FEAR

YOUNGSTOWN
Safety
LIMIT STOPS
for Crane Hoists

This Limit Stop not only *disconnects* the motor from the line, but *stops* the motor quickly. On D-c cranes, where high hoisting speeds prevail, dynamic braking aids in bringing the hook block to rest.

Since this Limit Stop is operated directly by the hook block, stretching of the hoisting cables does not affect the tripping point. By removing the fear of an overhoisting accident, the YOUNGSTOWN Limit Stop enables the crane operator to do better work.

*A crane *without* a Youngstown is as risky as a boiler *without* a safety valve.

Easily applied to both new and existing A-c and D-c Cranes.

WRITE FOR BULLETIN 1032

E&M

Industry News...

FAIRLESS WORKS BEGINS OPERATIONS

▲ On December 11 operations of the Fairless works began at Morrisville, Pa. A limited gathering of 200 persons, including officials of United States Steel and of Fairless works, and members of their families, watched Nancy Roach Fairless, seven-year-old daughter of Mr. and Mrs. Blaine Fairless, light No. 1 blast furnace. No. 2 blast furnace will be ready for production this month.

A few minutes later, Carol Sproul Fairless, Nancy's five-year-old sister, set off a jet rocket to light No. 1 open hearth furnace.

The two blast furnaces will produce 1,200,000 net tons of iron yearly, and, together with scrap steel, will be melted in the nine open hearths at Fairless works to produce 1,800,000 net tons of steel ingots each year. Work is progressing rapidly on other facilities which will have an annual capacity to produce 235,000 tons of hot rolled sheets, 289,000 tons of cold rolled sheets, 170,000 tons of tin mill products, 285,000 tons of bar products, and 280,000 tons of small diam pipe. Production of these important steel products is expected in the third quarter of 1953.

More than 4000 contractors and subcontractors located in 27 states and employing close to 3,000,000 people were engaged in the construction and tooling of Fairless works. Nearly 10,000 construction workers were employed on the site during the peak period this year. This huge mill, erected on 3900 acres of former farm lands in the bend of the Delaware River south of Trenton, N. J., has 75 miles of standard railroad track, 20 miles of improved roads, 30 miles of sewer, a water treating plant which will handle 254,000,000 gal of water daily, and several miles of belt conveyors. It has two batteries of 87 coke ovens each, one of which pushed its first coke two days ago.

PITTSBURGH COKE LIGHTS NEW FURNACE

▲ The lighting of Pittsburgh Coke & Chemical Co.'s new $8 million blast furnace at Neville Island, Pittsburgh, Pa., on December 11, marked the completion of another big step in the company's $34 million postwar expansion program.

The new furnace, with a hearth diameter of 22 ft, will add approximately 300,000 net tons yearly to the company's pig iron capacity. This brings Pittsburgh Coke & Chemical's total annual capacity to 800,000 tons.

The new furnace stands beside an older furnace which the firm has operated at Neville Island since 1929. A third furnace is located at Struthers, near Youngstown, Ohio.

This expansion strengthens Pittsburgh Coke's position as the only major merchant producer of pig iron in the Greater Pittsburgh area. Moreover, the new furnace provides a neat example of the company's closely integrated operations.

Slag from the new furnace will go to the company's nearby cement plant, also being expanded, where it will be used as a basic ingredient in the manufacture of cement.

The new iron-making facility ties into the firm's total operational plan in another direction by utilizing more coke from the company's expanded coke-making facilities. The newest battery of 35 by-product coke ovens was put into operation last October 7. The increase in the quanity of coal tars and gases recovered in the coking process gives the company more raw materials for its rapidly growing production of chemicals.

Equipped with the most modern dust-prevention and smoke-control devices, the new blast furnace was built by the Freyn Division of Koppers Co., Inc. Pittsburgh-Des Moines Steel Co., as sub-contractor, fabricated and erected a large part of the 6000 tons of steel used in construction of the furnace.

KENNAMETAL DEVELOPS HEAT-RESISTANT CARBIDE

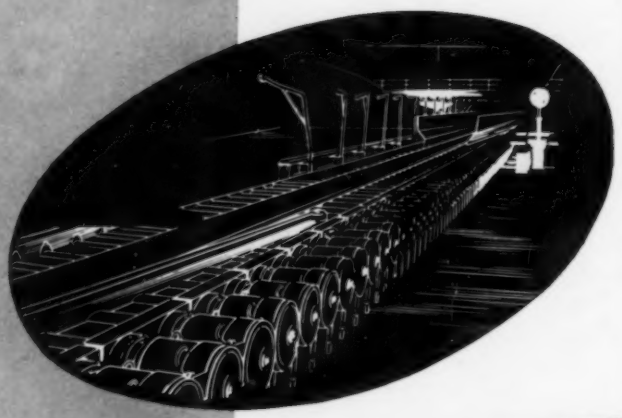
▲ Kentanium, a heat-resistant cemented titanium carbide has been

REBUILT BATTERY "B" PUSHES FIRST COKE

American Steel & Wire Division officials observe the "pushing" of the first coke from the newly rebuilt "B Battery" of the Cleveland coke works. There are 45 ovens in this battery — one of four in the Cleveland, Ohio, district of this division of U. S. Steel. The coke pouring into the gondola car is pushed out by a mechanical ram operated from the far side of the battery. Shown observing the operation are Fred H. Buskirk, special engineer; John E. Allen, general superintendent; Harry L. Jenter, Cleveland district manager; Van H. Leichliter, vice president of operations; and Emmett A. Brady, works superintendent.

AVOID COSTLY break-downs and shut-downs

on run-out tables too . . . . . with



LOVEJOY Flexible Couplings

Cushions last two to five years!

When you install Lovejoy Flexible Couplings on run-out tables and other equipment you save work and money by eliminating unnecessary down-time. Lovejoy Couplings correct mis-alignment without vibration, backlash or surge . . . no shut-downs for changing cushions . . . NO LUBRICATION EVER NEEDED.

Send today for complete catalog and quick-finding selector charts

LOVEJOY FLEXIBLE COUPLING CO.

5093 WEST LAKE STREET CHICAGO 44, ILLINOIS

Also Mfrs. Lovejoy Universal Joints and Lovejoy Variable Speed Transmissions

developed exclusively by Kennametal, Inc., of Latrobe, Pa.

Several programs are under way to use the new material for high-powered longer life commercial gas turbines. This field of application involves the desired temperature of 1600 F and long time operation of 5000 hours minimum.

Engineers who have reviewed the metals available for this level of operation have found no material other than Kentanium that gives promise of being adequate for the job. Kennametal, Inc. has designed and built a small radial inward-flow gas turbine for operation at 2000 F and above.

Two steel plants in the Pittsburgh, Pa., area are testing the use of Kentanium for use in ladle tongs and thermocouple protection tubes.

Over a period of several years Kennametal, Inc. has conducted extensive research and developed completely integrated processes from ore to finished product. This effort, totalling $2,000,000, has been financed entirely by the company, and complete pilot facilities are today in existence at Latrobe, Pa.

Kentanium is a series of cemented carbide compositions or alloys based on titanium carbide and produced by the same powder metallurgy methods by which cemented tungsten carbide tools are made. These compositions are unique materials in that they combine high-temperature strength with thermal shock and oxidation resistance to provide a combination of properties never before obtainable to industry.

Structural alloys — those that can be melted and precision cast, or cast and forged, or otherwise hot-worked to shape — are limited in the temperatures at which they will withstand heavy loads. This limitation is due both to the nature of such materials and the operations required to make and shape them. Kentanium retains its strength at temperatures several hundred degrees in excess of those possible with alloys. Ceramics retain their strength at high temperatures and are resistant to oxidation, yet for many applications they are far too brittle and deficient in thermal shock resistance. Kentanium is virturally the equal of the alloys in thermal shock resistance and ductility.

Kentanium has titanium carbide as its chief ingredient, with nickel as the primary auxiliary metal, or other metals, as conditions dictate. Most

Announcing

F&Ym CONTINUOUS STRIP PICKLING LINE

NEW · EFFICIENT · ECONOMICAL

Complete line equipment with latest improved operating features. Maximum volume production with minimum floor space requirements.

If you are interested in a new installation or improving your present equipment why not investigate the Youngstown Line!

these features

- ☐ Coil Box with Strip Opener.
- ☐ Triple Processor with Roller Leveller.
- ☐ Flash Welding and Mechanical Stitching.
- ☐ Single Cycle Up-Cut Shears.
- ☐ Heavy Duty Rubber Covered, Brick Lined Steel Tanks.
- ☐ Magnetic Loop Control for Acid Tanks.
- ☐ Fume Exhaust System—Roto Clone Scrubber.
- ☐ Automatic Control System for Temperature and Acid Proportioning.
- ☐ Side Trimmer with Scrap Cutting or Balling.
- ☐ Up-Coiler with Strip Oiling System.
- ☐ Entry and Exit Coil Conveyors.

The Youngstown Foundry & Machine Co. F&Ym

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

9

FEATURING:

- OPERATING ECONOMY
- GREATEST DURABILITY
- LOWEST MAINTENANCE

You can save REAL money on the operation of electric trucks. Ready-Power DIESEL-Electric drive is the answer. Actual tests prove savings of 40% to 70% in operation and maintenance. Rugged DIESEL design provides *more* work per gallon of fuel, *longer* life span and *less* maintenance. And Ready-Power DIESEL-Electric Units provide the most efficient, most constant, most economical power source for electric industrial trucks.

Remember...Your Truck Is No Better Than Its Power!

CONTINUOUS-DUTY POWER UNITS

The READY-POWER Co.

3836 Grand River Ave., Detroit 8, Michigan

Manufacturers of Gas and Diesel Engine-Driven Generators and Air Conditioning Units; Gas and Diesel-Electric Power Units for Industrial Trucks

compositions contain a small percentage of columbium carbide which is highly effective in making the compositions resistant to oxidation, and is used when this property is required.

Unlike conventional alloys, Kentanium is not melted and cast, but is made by advanced methods of powder metallurgy that produce a material of remarkable uniformity and soundness.

Facilities at Kennametal, Inc. have been greatly expanded to serve industry with a wide range of parts made of Kentanium. They have improved an extrusion technique which produces shapes such as tubes, rods, bars, flats, and even objects having complex geometrical cross-sections. More intricate parts are machined from pressed slugs. Should high dimensional accuracy be demanded, the required tolerance, or finish, is accomplished by grinding after parts are furnace-sintered.

GOULD-NATIONAL MOVES N. J. SERVICE CENTER

▲ Improved service is being provided for commercial users of storage batteries in the New York-New Jersey area with the removal by Gould-National Batteries, Inc., of its northeastern area service and repair center from North Bergen, N. J., to larger quarters at 309 51st street, West New York, N. J.

The newly-installed service center of Gould-National Batteries Co. at West New York, N. J. provides facilities for handling all types of industrial batteries. Carrying a complete line of batteries and parts, the center will also provide more rapid service for commercial users.

Well equipped and with 5,000 sq ft of floor space, the new center will stock new batteries as well as a com-

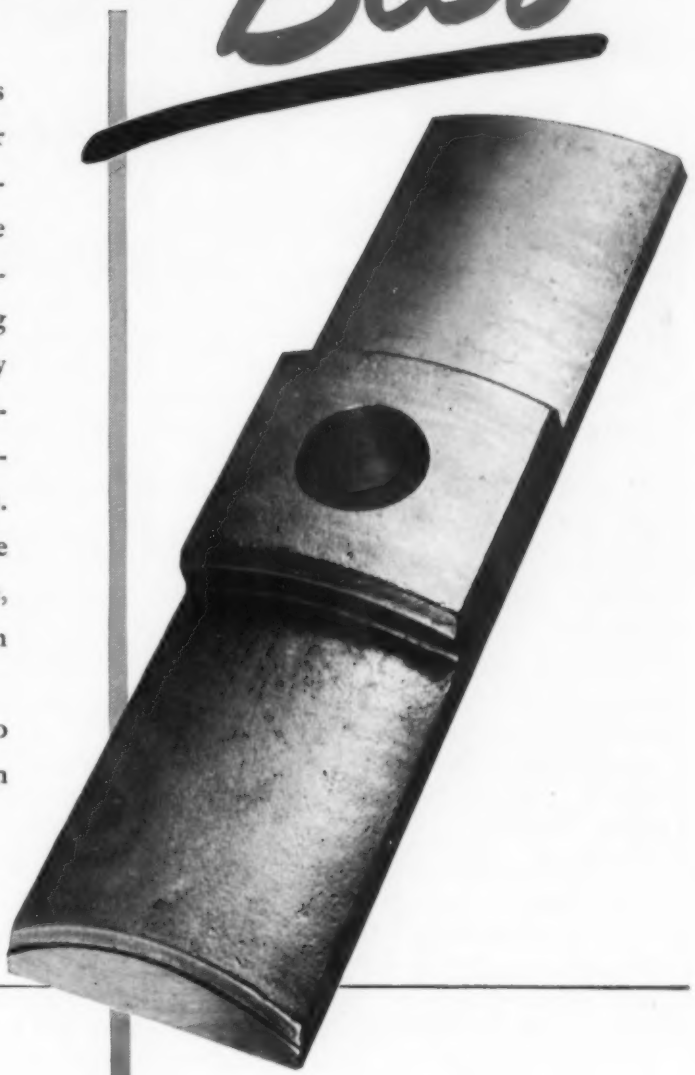
We Serve Steel Better Best

Knowing Copper Alloys

We specialize in copper and copper-base alloys such as bronze. And we cast these metals for steel industry use by the most advanced methods. For example . . . this aluminum bronze slipper is made by our permanent mold technique and requires *no machining* after casting except for the pin hole. Oil grooves are actually cast-in. Surface hardness is completely controlled, and our customers realize dollar savings through our production-run economies.

National Bearing Division offers you the benefits of more than 50 years of experience, metallurgical research and production-run facility development.

Our 6 centrally located plants are ready to serve you. Contact National Bearing Division for full information.



A FEW NATIONAL BEARING STEEL INDUSTRY PRODUCTS: Bosh Plates • Monkeys • Tuyeres • Coolers • Mantel Plates • Stack Plates • Roll Neck Bearings • Housing Nuts • Babbitt Metals • Slippers

You're invited to visit us at our plant in Meadville, Pa. . . . We'll be glad to have you know us better.

Brake Shoe

NATIONAL BEARING DIVISION

4936 Manchester Avenue • St. Louis 10, Mo.

PLANTS IN: ST LOUIS, MO • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet

Subject: HOW GRANODRAW PHOSPHATE COATING FACILITATES COLD EXTRUSION OF STEEL

INTRODUCTION

By phosphate coating steel, prior to cold working it, extrusion, drawing, and other forming operations are greatly improved. In fact, it is the protective zinc phosphate coating that makes for the successful cold deformation of steel.

The tremendous pressures that most forming operations require produce extremely high frictional contact between die and metal. Without a protective coating, excessive galling (welding) of dies, breakage of tools, and unduly short die life will result. The combination of a non-metallic crystalline phosphate coating with an adsorbed lubricating film, possesses a low coefficient of friction while maintaining its stability under extremely high deforming pressures. This combination, therefore, greatly minimizes the aforementioned tool difficulties.

THE COLD EXTRUSION OF GENERATOR FRAMES

Cold extrusion is now being used advantageously in the manufacture of high production generator frames. This operation is facilitated by careful preparation and proper coating of the frame blank which is made from SAE 1010 open hearth plate steel.

After wheelabrating to remove the scale, the blank is rolled up and then fed automatically through a six stage dip wheel type washing machine which cleans the surface and applies the coating. The frame is then fed into an extrusion press where the wall thickness is increased on one end and reduced 47.5 percent on the other end. This operation produces concentric frames of uniform thickness and correct dimensions.

The Granodraw coating produces the proper surface to receive the lubricant by furnishing an extremely adherent film with the proper crystal size and continuity of coating required to insure maximum adsorbsion and tenacity by the lubricant. The lubricant, Montgomery DF 1101, is a combination of titre alkali soaps and resins. It is a powder which when dissolved in water and redeposited on the phosphate coated work piece, produces the necessary surface for subsequent operations. This film is dry and considerably less hydroscopic than similar coatings of the soap type. The concentrations of both the Granodraw and DF 1101 are maintained by simple chemical analysis.

PROTECTIVE COATING SEQUENCE

Stage	Operation	Chemical	Time	Temperature
1	Load and unload			
2	Cleaning	Tri-sodium phosphate and soda ash	1 Min.	180° F
3	Water rinse		1 Min.	180° F
4	Zinc phosphate coating	"Granodraw"*	4½ Min.	165° F to 180° F
5	Water rinse		2 Min.	180° F
6	Lubricating	H.A. Montgomery lubricant DF 1101	4½ Min.	190° F

*Trade Mark of the American Chemical Paint Company

CHEMICALS ACP PROCESSES

plete line of battery parts. It will also expedite the rebuilding and repair of commercial batteries used in such fields as material handling trucks, telephone circuits, railway signal and control circuits in eastern New York north to Albany, southern New England, Long Island, northern New Jersey and eastern Pennsylvania.

Additional equipment in the new center includes a heavy-duty monorail conveyor, and motor-generator charging equipment capable of handling even the largest industrial batteries. James E. Vaughan, Jr. is manager of the new station.

MESTA EMPLOYEES RECEIVE SERVICE PINS

▲ On January 5, Mesta Machine Co. made its fifth annual distribution of service awards to those men and women who have served the company for from 10 to 50 years. This year 289 employees were recipients of the awards. Since the program was inaugurated in 1948, 3247 awards have been made.

A gold service pin with the company's name inscribed is awarded to employees with ten years' service. The twenty-year pin has a ruby mounting, the thirty-year pin a sapphire mounting, and the forty-year pin a diamond mounting. A suitable gift, such as a fine watch, is awarded to employees with 50 years' service.

One hundred and ninety 10 year pins were presented yesterday, and 73 joined the 20 year group. The eighteen employees who received 30 year pins are: Louis W. Easer, Carl O. Magnuson, Jose Muner, Hugh J. Doyle, George Bicsey, Joseph Smorgoleski, John C. Boyer, Oscar C. Bennett, John Wozniak, Walter Stolte, Gerard J. Grefenstette, George D. Chisholm, Donato Mastascuso, James B. Kent, James A. Ross, Wilbert F. Fuller, Andy Bulyko, Michael A. Vandzura.

Charles W. Mesing, Clarence E. Ashbaugh, Joseph Smith, Frank M. Dosch, Jacob L. Knoedler, were the five receiving awards for forty years' service.

The three who have rounded out fifty years of service, and were presented with watches were president Lorenz Iversen, Carew W. Beers, and Nicholas A. Falce. Lewis W. Mesta, executive vice president of the company, made the presentations.

(*Please turn to page 196*)

ENGINEERING REPORTS:

WORLD'S LARGEST continuous strip annealing furnace is co-ordinated with the G-E drive for a capacity up to 30 tons per hour of 18- to 37-inch strip. Protective gas atmosphere in furnace protects the strip against oxidation.

New line anneals strip at 1000 fpm

Co-ordinated G-E drive and furnace help produce up to 30 tons per hour

Another step toward higher-speed steel-making is the continuous cleaning and annealing line recently started by a large Indiana mill—with co-ordinated G-E drive and annealing furnace. Engineered by G.E. and United Engineering & Foundry Co. to handle a 18- to 37-inch strip at speeds up to 1000 feet per minute, it provides these advantages over batch methods:

SPEEDS OUTPUT with continuous, 24-hour operation.

SAVES TIME. No need to transport coils from cold mill to cleaning unit to furnaces. Annealing cycle is cut, too.

IMPROVES PRODUCT. Furnace's precise temperature control gives strip greater uniformity.

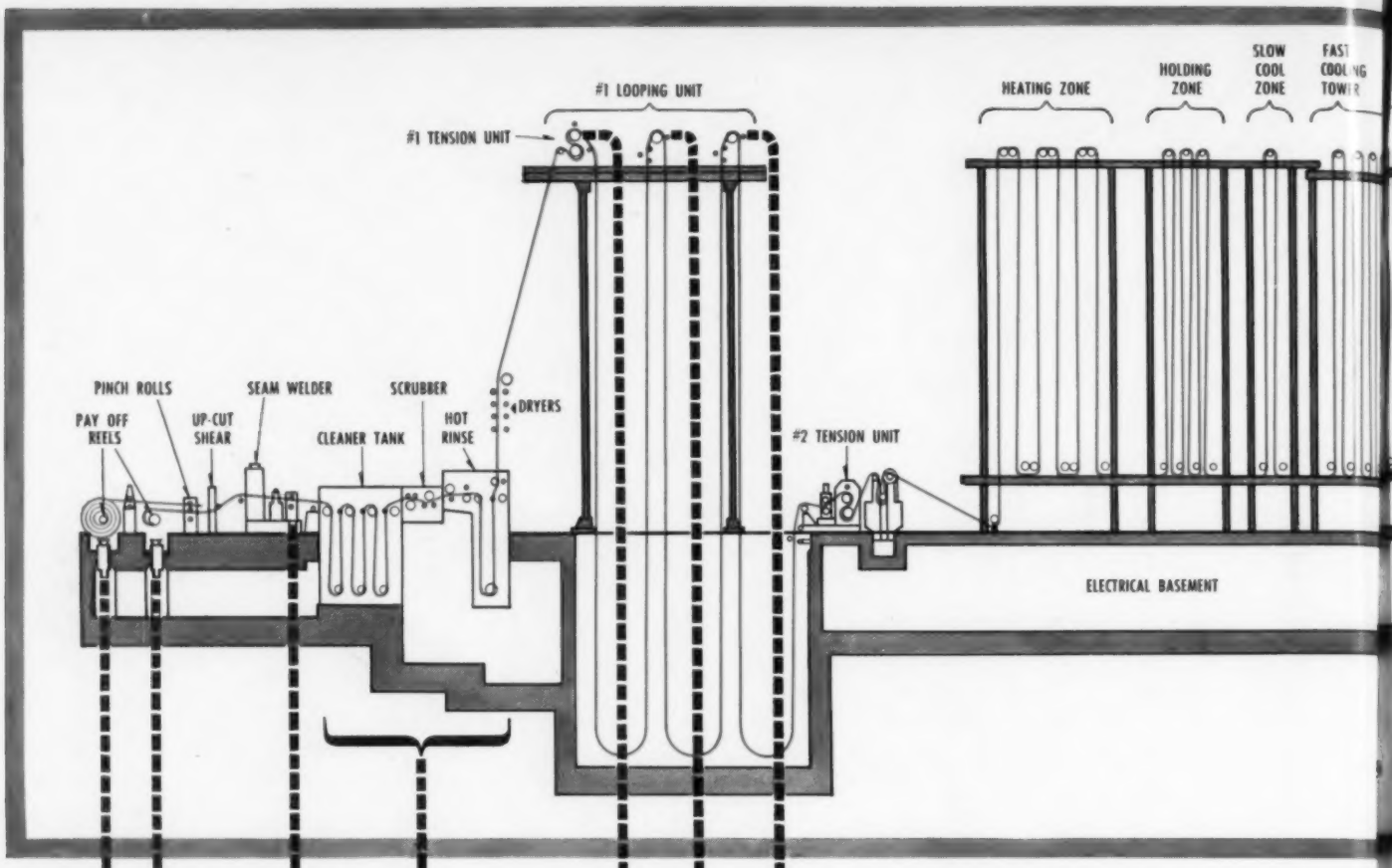
SAVES MANPOWER. Fully automatic amplidyne control of tension, loop position and overspeeding permits operation of entire line by as few as three men.

SAVES SPACE. Continuous cleaning and annealing reduces needed equipment area and storage space.

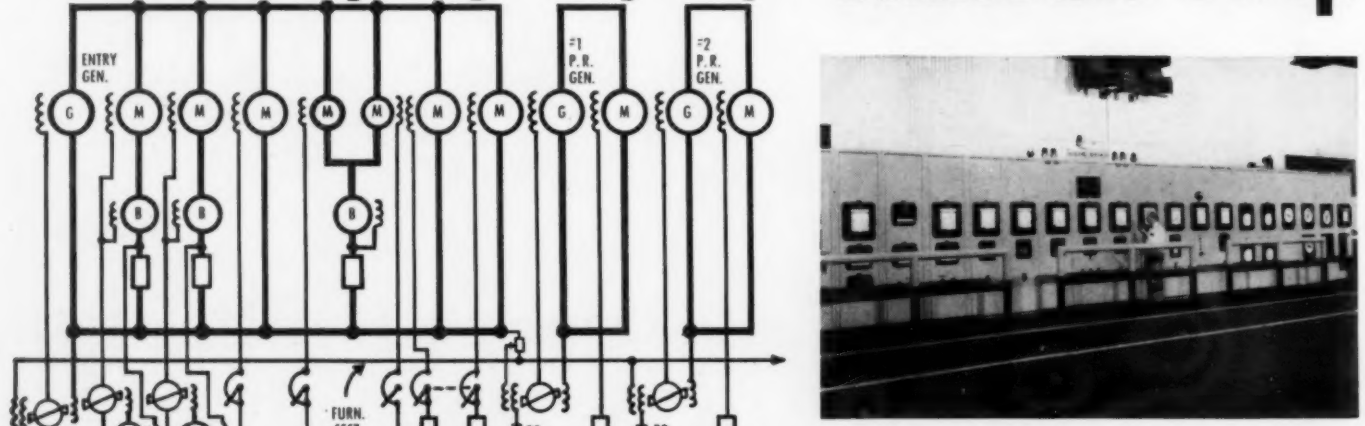
An **engineered system** approach by a G-E steel-mill specialist can help solve **your** drive problems as well. Contact your local G-E Apparatus Sales Office. General Electric Co., Schenectady 5, N. Y. 659-90

For engineering details, turn page

GENERAL ELECTRIC



Anneals strip



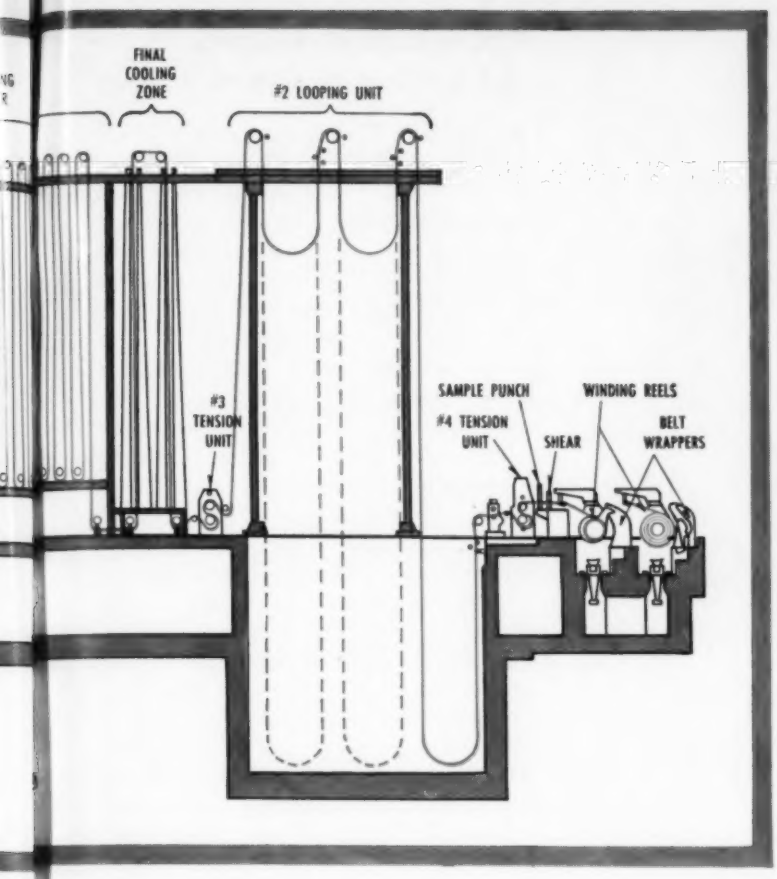
PRECISE TEMPERATURES maintained by G-E furnace and furnace-control panel help give strip more uniform physical qualities and surface conditions.

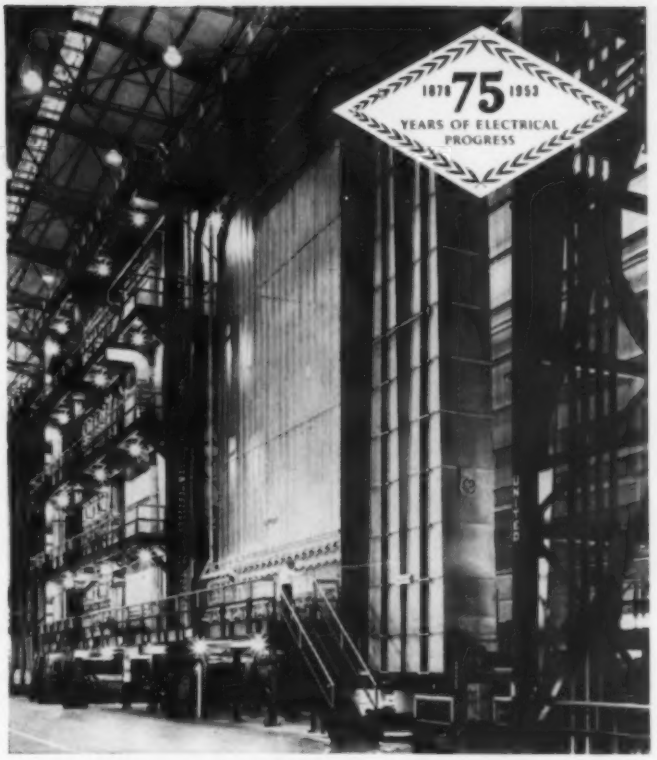
HOW THIS G-E ENGINEERED DRIVE WORKS

A motor-operated rheostat sets line speed by controlling the furnace-section generator voltage. Voltages of the entry and delivery section drives, and the tower pinch rolls, are regulated to keep the entry storage loops full and the delivery storage loops empty during normal running. The furnace-section voltage is used as a reference for an approximate speed match, with the photo-electric loop controls (LC) acting as overriding vernier regulators to maintain accurate loop position.

To start a new coil, the entry section is decelerated to a stop under current limit, while the "half-speed" pinch roll (No. 1PR) empties the loop evenly. This permits the strip to continue through the furnace at a constant speed during the time required to weld together the ends of the new and old coils. The entry section is then accelerated, again under current limit, to an overspeed condition until the storage loops are refilled. Full coils of annealed strip are removed from the delivery end of the line in a corresponding manner.

Another example of G-E drive engineering at work!





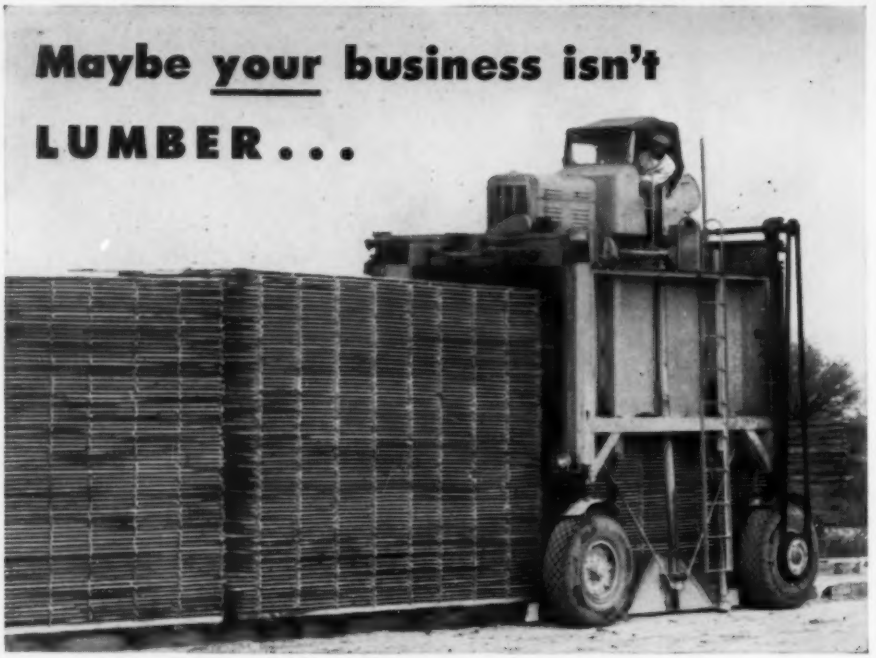
CONTINUOUS OPERATION is maintained in the line (shown from delivery end) with help of amplidyne-controlled storage loops for strip between furnace section and each end section.

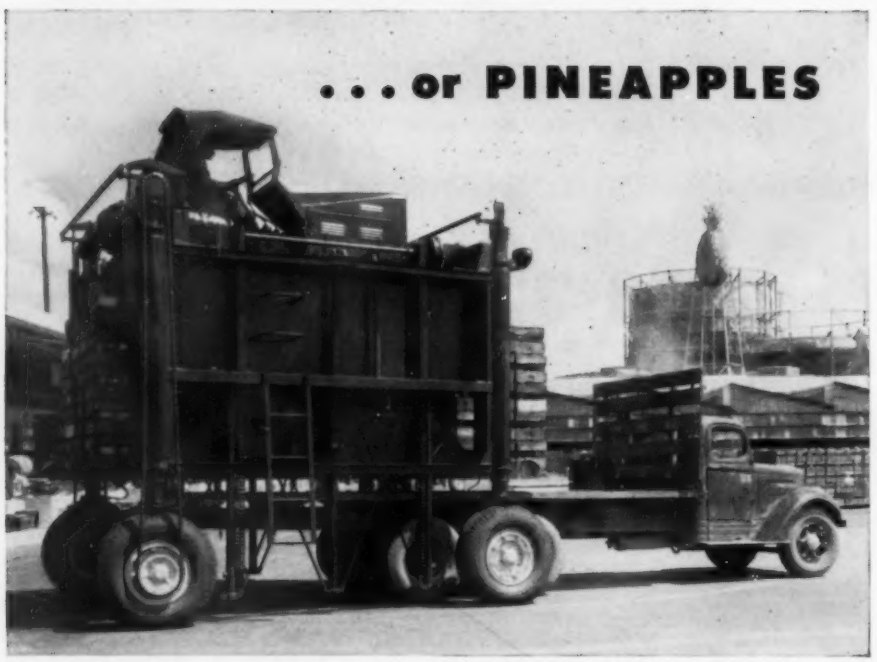
continuously, more uniformly

13 FEET BELOW main floor—in the "electrical basement"—are these adjustable-voltage m-g sets, and 92 feet of G-E d-c control assembled back to back on a 46-foot-long framework.

64 FEET ABOVE main floor—atop the furnace—these G-E gear-motors drive fast-cooling and final-cooling section rolls. General Electric motors in the entire line total over 1700 hp.

GENERAL ELECTRIC





BUT . . . just imagine the savings you could make, the problems you could solve by handling your materials with ROSS Straddle Carriers, the most flexible and most adaptable mass material handling method known!

ROSS engineers will be glad to work with your materials handling men in exploring the possibilities of ROSS Straddle Carriers for your operations . . . there's no obligation.

Send for details on ROSS Straddle Carriers . . . 10,000 lb., 20,000 lb., 35,000 and 45,000 lb. capacities.

Rely On ROSS

THE ROSS CARRIER COMPANY

Direct Factory Branches and Distributors throughout the world.

400 Miller St., Benton Harbor, Michigan, USA

PRODUCTION BEGINS AT NEW VANADIUM PLANT

▲ Production of alloys was started recently at the new, $2,500,000 plant of Vanadium Corp. of America near Cambridge, Ohio. The plant is located on a 120-acre site which is about 100 miles from the company's new, $8,000,000 alloy producing plant at Graham, W. Va. The facilities include three low frequency induction furnaces previously operated at the company's leased Chester, Pa., plant which was returned to the United States Government for re-activation by the Air Corps.

At the present time, activities at the Ohio plant are confined largely to the manufacture of aluminum alloys. An office building and a laboratory are under construction at the site. A pilot plant for experimental work in aluminum and alloy metal production is scheduled to be built, also. Ferro vanadium, grainal alloys, low carbon ferro titanium and other alloys will be produced when construction of the plant is completed next year. At that time, approximately 250 persons will be employed.

An addition is being made to the company's Graham, W. Va., plant, at an estimated cost of $3,500,000, to permit production of very low carbon ferro chrome, a high quality alloy necessary for new types of high temperature resistant steels and certain types of stainless steels.

COLUMBIA ANNOUNCES RECENT ACQUISITION

▲ Columbia Machinery and Engineering Corp. has acquired all of the assets and manufacturing rights of the Bridgeport Safety Emery Wheel Co., Inc., of Bridgeport, Conn., and the Diamond Machine Co. of Stratford, Conn. The acquisition of the two machine tool concerns climaxed several months of negotiations, and it was reported that these companies were purchased for cash.

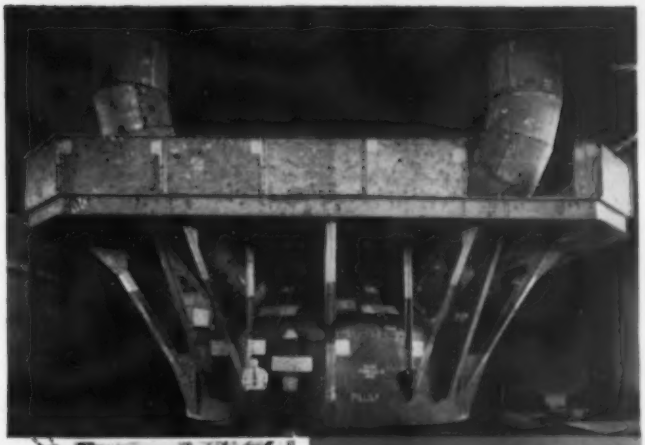
Columbia plans to integrate the two Connecticut companies, for the time being, with its Hamilton, Ohio division.

DELTA-STAR MERGES WITH H. K. PORTER CO.

▲ Delta-Star Electric Co. has been merged into the parent company, H. K. Porter Co., Inc. and will operate as Delta-Star Electric division.

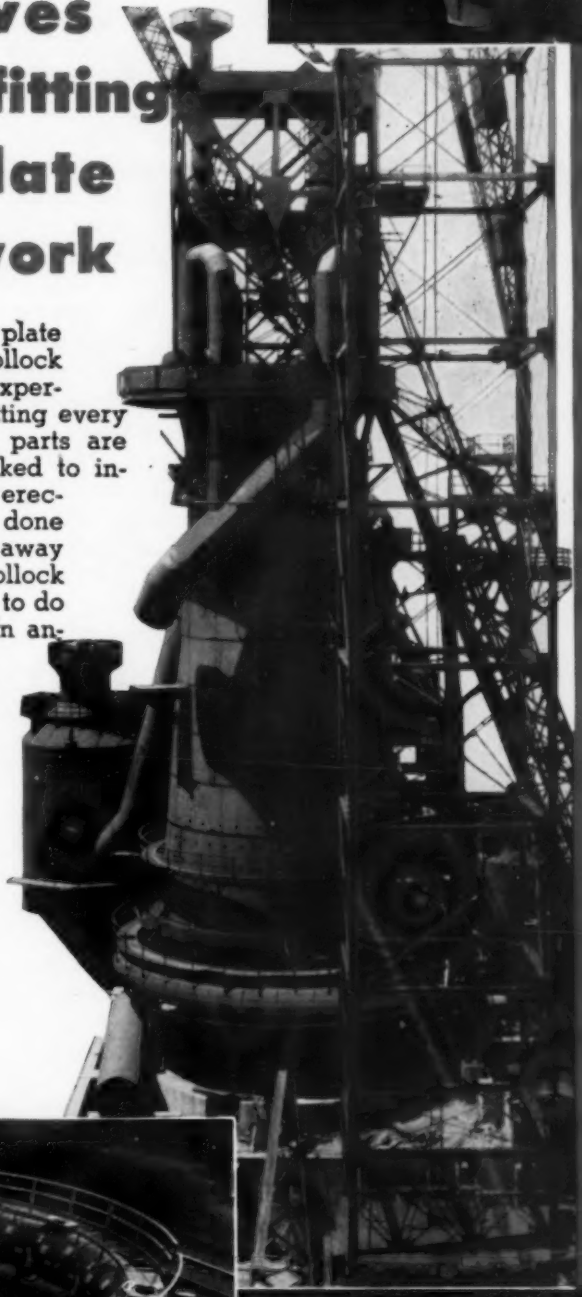
from TOP to BOTTOM

POLLOCK gives you precision fitting in all steel plate construction work



Let Pollock handle your next steel plate fabrication and erection job, for Pollock skilled experts have had years of experience . . . can give you precision fitting every time! Before leaving the shop, all parts are assembled and carefully match-marked to insure close, accurate fits and speedy erection in the field. So carefully is this done that one customer — 12,000 miles away — has ordered steel work from Pollock **three** times, and each time was able to do his assembling quickly and easily. In another instance, the Pollock Company tore down and rebuilt the steel work for an **entire** blast furnace which was out of operation only 83 days, setting a new world record and saving over 70,000 tons of pig iron.

You, too, can benefit from Pollock's broad experience . . . its complete facilities and well-trained engineering-designing staffs. Whatever your fabricating job — large or small — heavy or light — put it up to Pollock and see how you save!



Blast Furnaces

Hot Metal Cars and Ladles

Ingot Mould Cars

Cinder and Slag Cars

Charging Box Cars

Welded Open Hearth Ladles

Welded Steel Products

The WILLIAM B. POLLOCK CO.

YOUNGSTOWN, OHIO

•

STEEL PLATE CONSTRUCTION

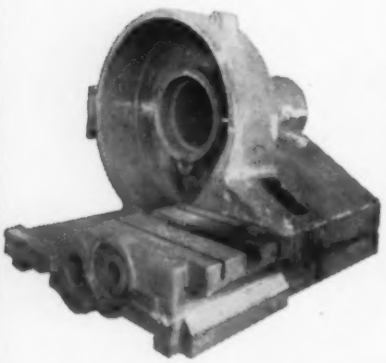
ENGINEERS FABRICATORS ERECTORS

Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

Gray Iron Castings

Castings of any size up to 80,000 pounds. Hyde Park facilities are equal to your every requirement



Machine Castings
Lathe Beds
Housings
Pinion Housings
Mill Housings
Shoe Plates
Layout Plates
Surface Plates

Hyde Park

FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland County, Pa.
ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

Policies, management and operation of the new Delta-Star Electric division will remain the same, with C. S. Beattie continuing as general manager of the division.

Both Mr. Beattie and R. E. Anderson have been elected vice presidents of H. K. Porter Co., Inc.

PROCESSING PROGRAM IS PLANNED BY ARMCO

▲ Armco Steel Corp. has announced plans to add new processing facilities estimated to cost around $12 million to its plant at Ashland, Ky. This is in addition to the $35 million hot strip mill now nearing completion.

The new program includes a cold reduction mill, a continuous cold strip pickler, and both light and heavy gage zincgrip lines.

The new facilities are part of Armco's overall program of expansion and modernization. They will bring melting and rolling facilities at the Ashland division into balance, and will increase yield through employment of the most modern practices. It is expected that the new facilities will go into operation sometime in 1954.

KOPPERS EXPANSION WILL INCREASE SERVICES

▲ Production from new and expanded installations and the introduction of new and improved products will considerably enlarge the services of Koppers Co., Inc., to industry.

At Fontana, Calif., the new plant of Koppers Tar Products division in the first quarter will reach full production of coal tar pitch roofing, pitches, and other coal-tar products, in addition to coal-tar-base pipe coatings. This new plant, the largest of its type on the West Coast, will process and refine all of the coal tar obtained from the coke ovens at the local Kaiser Steel Corp. plant.

Large scale applications of the Koppers-Hasche furnace, which aroused considerable interest in 1952, are expected in 1953 for reforming natural gas or for manufacturing substitute gases from gasoline.

Continuous casting of ferrous and non-ferrous metals will be more widely accepted during 1953, during which Koppers will design and erect the first continuous casting machine for the production of alloy steel at Welland, Ontario.

Services of Koppers Engineering and Construction division will be applied to coke and steel plant construction at a continuing high level during 1953 with 918 of 1110 of the ovens currently contracted for are scheduled for completion during the coming year. During 1952, 527 chemical recovery coke ovens were placed in operation as well as four new blast furnaces, seven new open hearths; an open hearth plant of four furnaces was placed in operation. A battery of nine open hearth furnaces will be placed in operation in 1953.

In addition to plant and production expansion and improvement, the scope of Koppers research will be broadened with the full utilization of its new Verona Research Center which contains more pilot plants than have ever before been operated by Koppers.

ATLANTIC STEEL WILL RESUME FABRICATING

▲ Atlantic Steel Co., Atlanta, Ga., will resume the fabrication of concrete reinforcing bars through its fabricating division.

The company has been a producer of deformed reinforcing bars for over twenty-five years, and was also active as a fabricator until 1942. Dixisteel reinforcing bars have been widely used in the construction of concrete bridges, highways and buildings throughout the South.

During the past three years, Atlantic Steel's production of reinforcing bars has been double the average of previous years, including the peak demand of World War II, and most of this tonnage has been used in important defense projects.

The fabricating division will maintain a staff of engineers to detail blue prints and drawings, and to list bills of materials. New bar-bending equipment of the latest design is being installed, and crews have been trained in their use.

Other services available to customers through the company's fabricating division are hot-dip galvanizing, heat-treating and special-order forging and stamping.

PLANT COMPLETION IS ANNOUNCED BY FEMCO

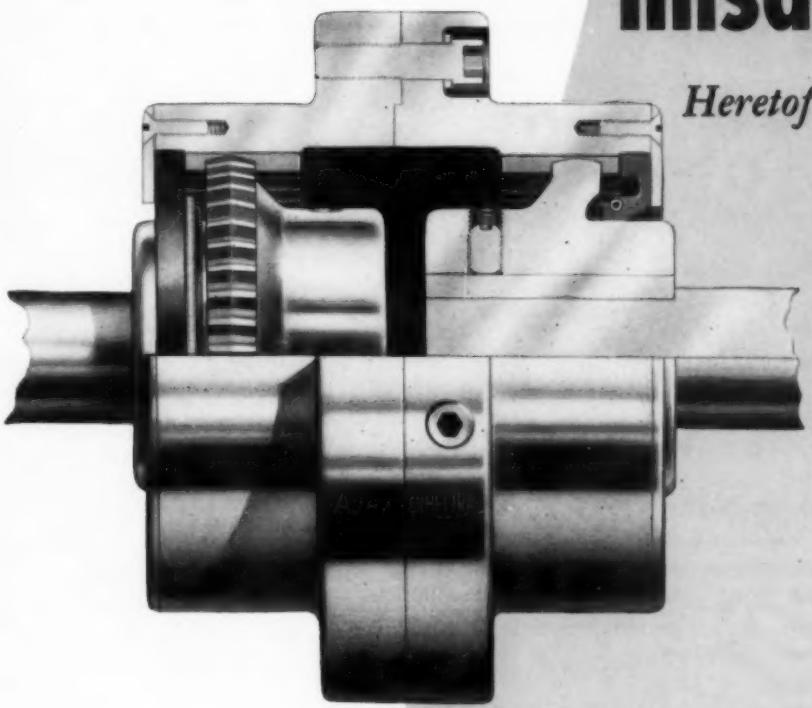
▲ Farmers Engineering and Manufacturing Co., designers and makers of Femco products for electronic communication and control, has announc-

AJAX DIHEDRAL

FLEXIBLE COUPLINGS

provide for AND protect against misalignment

Heretofore Considered Excessive



Ajax Dihedral surfaces of gears provide maximum bearing area and do not tend to rupture the oil film. This contributes to long life, cool running and quiet, chatter-free operation.

All gear teeth hardened to 50 to 55 Rockwell C.

* The performance of Ajax Dihedral Couplings confirms the fact that *there is no competition with quality.*

Design, installation and maintenance men are saving thousands of hours, and dollars by eliminating necessity for precision alignment of direct-connected machines.

New and exclusive Ajax Dihedral tooth shape provides for extreme misalignment with tooth clearance (backlash) kept to oil film requirements. Long life is assured because more tooth contact is maintained under operating conditions.

Positive oil seals keep lubrication in and dirt out.

Write for Bulletin 50.

AJAX FLEXIBLE COUPLING CO. INC.

WESTFIELD, NEW YORK

ed the completion and opening of a new plant at Irwin, Pa. The value of the building, land, equipment, patents and inventory is estimated by the company's auditors to exceed one million dollars. The Femco firm was formerly located on Brushton Avenue in the Homewood section of Pittsburgh.

The new plant site consists of 7 acres situated on a wooded hill, close by the Irwin interchange of Route 30 and near to the Irwin entrance of the Pennsylvania Turnpike.

AMERICAN STEEL & WIRE PLANS BLAST FURNACE

▲ American Steel & Wire division of U. S. Steel Corp. has plans for construction of a new blast furnace in Cleveland to serve the growing demand for iron among the iron and steel foundries in the Cleveland, Ohio, area. The new furnace, to be built at the Central Furnaces and Docks plant of American Steel & Wire division, will have a capacity of 1350 tons a day.

Engineering work has started and will be carried on as rapidly as possible. The new furnace will represent the ultimate in modern blast furnace construction, and will incorporate the very latest devices such as gas-cleaning equipment to avoid atmospheric pollution.

The new furnace, to be known as "A" furnace, will supply vital pig iron for a large number of defense-supporting industries in the Cleveland area.

SLOSS-SHEFFIELD MERGES WITH U.S. PIPE

▲ Sloss-Sheffield Steel and Iron Co. has been merged into United States Pipe and Foundry Co. Sloss-Sheffield will operate as a division of United States Pipe and Foundry Co. and will continue to be headed by Fred Osborne as president. Hugh Morrow, who was chairman of the board of Sloss-Sheffield and had formerly been president for many years, was elected vice chairman of the board of directors of United States Pipe and Foundry Co.

United States Pipe and Foundry Co. has owned a majority interest in Sloss-Sheffield since 1942. The latter company has been a major source of pig iron and coke for the pipe company for many years. Sloss-Sheffield division will continue as at present to maintain and develop its position as a producer and seller of merchant pig iron, coke and other products in the Birmingham, Ala., district.

AMERICAN WHEELABRATOR MOVES N. Y. OFFICE

▲ American Wheelabrator & Equipment Corp., Mishawaka, Ind. announces that its district office in New York City has been moved to 53 Newark Street Building, Hoboken, N. J. The move was designed to provide better service to users of blast cleaning equipment, blasting abrasives, chemical and metallurgical dust and fume collectors, and other supplies for foundries and metal-working concerns which are located in the portions of Pennsylvania, New York, Connecticut, and New Jersey served by this office.

SUBSIDIARY BECOMES DIVISION OF J&L

▲ Jones & Laughlin Supply Co., Tulsa, Okla., a wholly-owned subsidiary of Jones & Laughlin Steel Corp., became a division of J&L on January 1, 1953.

On that date all of the assets of the J&L Supply Co., which serves the oil country with 88 stores throughout the western and southwestern part of the United States, were transferred to the parent corporation. The supply division supplies tubular goods, pumping units, wire rope, and a complete line of oil country equipment to oil well drillers and oil producers in 18 states east of the Rockies, and in Alberta, Canada.

Canadian assets of the J&L Supply Co. will be sold to the J&L Steel Sales Co., Ltd., a Canadian subsidiary, which will carry on the Canadian business previously conducted by the J&L Supply Co.

COLMAR PLANT FEATURES EXPANSION FACILITIES

▲ Manufacture of custom-designed conveying and processing machinery has been put on a straight-line production basis in the new 300,000-sq ft plant of Link-Belt Co. at Colmar, Pa., 25 miles north of Philadelphia. The Colmar plant is Link-Belt Co.'s seventeenth.

The Colmar plant is of modern design, with large, uncrowded work areas. It combines straight-line production with utmost flexibility. Changes in layout can be made to suit a wide variety of products.

The new Link-Belt Co. plant has an overall length of 880-ft with overhead bridge cranes in four of five 60-ft bays where 32-ft clear heights have been provided, as well as in the higher (42-ft clearance) receiving and shipping bays at either end. Engineering activities occupy the entire second floor of the face brick office building at the front of the plant which has been designed to permit expansion to double the present size of the manufacturing area.

The plant is 880 ft long, 300 ft wide, with a two-story office building.

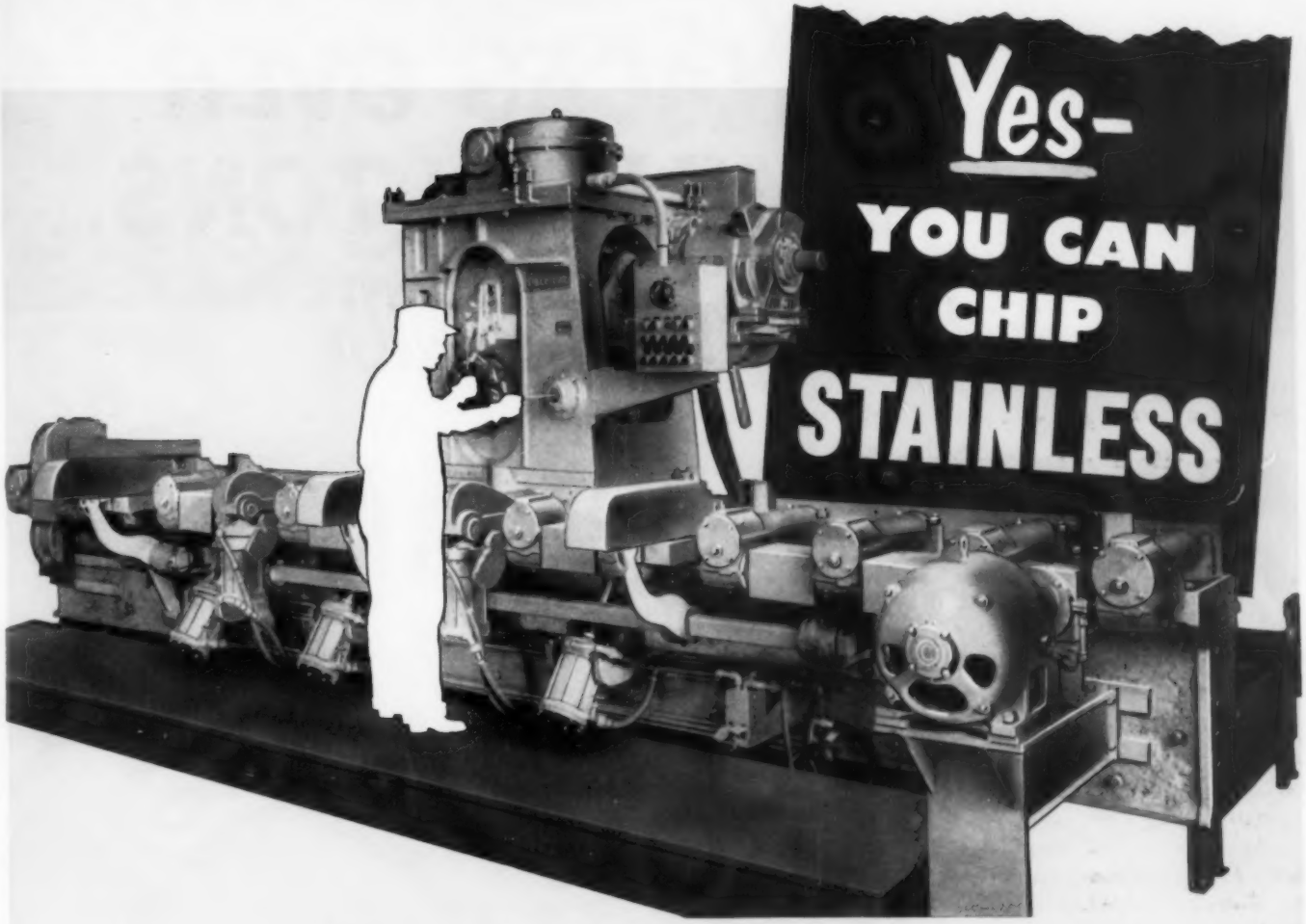
Craneways in four of five 60-ft production bays, with 32-ft clearances below trusses, extend under still higher transverse craneways in the receiving and shipping cross bays at either end.

Receiving and shipping areas are designed for efficient movement of truck and rail shipments. Reading Railway spurs run directly into the plant at each end. One of these sidings extends through the plant, enabling Link-Belt to store heavy materials in the graded area at the rear of the manufacturing plant.

The railroad sidings are set flush with the floors, permitting trucks as well as trains to use this space. Concrete roadways extend into the plant. In addition, depressed truck docks are provided at each end of the building.

The layout, design for an ultimate expansion to double the present manufacturing area, provides a plant with separate offices and toiiet facilities, and an office building complete with all necessary facilities, including a cafeteria and medical dispensary.

The project also includes a complete sewage treatment plant, at the rear of the building site, with primary and secondary settling tanks and biofilters. This equipment is manufactured by Link-Belt, and so it also serves as a laboratory and demonstration unit.



. . . and the Bonnot Billeteer easily handles other "Tough Babies" too!

Bonnot Billeteering is producing surprising results with stainless steel. While we are not inferring that the "highest-brinell rated" stainless is being chipped, *exceptional results are being consistently obtained in brinell classifications under 400.*

And when it comes to toughness, let's consider 52100 high chrome, high tensile steel that's always a problem to condition:

With a Bonnot Billeteer the operator completely skinned (full surface removal) *in just 8 hours,* 8 sides of 7" square blooms, 10' long plus 5 sides of 14" square, 15' long *. . . 2900 square inches per hour with Bonnot Billeteering.*

Yes, steels of the toughest varieties—with or without annealing treatment—are being successfully chipped by the Bonnot Billeteer every day, everywhere in the industry.

If you still are struggling with laborious, dangerous billet conditioning methods it will pay you to find out about Bonnot Billeteering. A real investigation of production being obtained may surprise you greatly. Never a better time to find out—and never an obligation.

Engineered For Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

Also Manufacturers of — SAWING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES
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42 FURNACES OVER A MILLION TONS...

and still going strong with

NATIONAL CARBON
TRADE-MARK

BLAST FURNACE LININGS

Of these 42 "National" carbon-lined blast furnaces, 13 original linings have produced from 1 to 1½ million tons; 18 from 1½ to 2 millions; 10 have produced between 2 and 2½ millions; and 1 lining has topped the 2½ million ton mark. Every year more "National" carbon goes in . . . *stays* in to produce record tonnages, record low cost and *smooth* operation. More and more, it pays to watch the growth of CARBON in modern steel-making equipment.

•

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ELECTRIC FURNACE ELECTRODES • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS

Personnel News...

Van H. Leichliter has been named vice president of operations of American Steel & Wire division of U. S. Steel Corp. Mr. Leichliter, who has been assistant vice president of operations since February 1, 1950, succeeds Walter F. Munford who assumed the presidency of the wire division on January 1. Mr. Leichliter was first employed by American Steel & Wire in mill metallurgical work in Worcester in February, 1930.

Dwight S. Ewalt, formerly sales manager, has been elected vice president and general manager of Rust Furnace Co. Mr. Ewalt succeeds the late **W. R. Culbertson. O. D. Rice,** manager of operations was elected to a directorship. **Richard W. Ewalt** was promoted from assistant manager to manager of sales.

George B. McMeans was appointed vice president in charge of operations for Kaiser Steel Corp., Fontana, Calif. Mr. McMeans' headquarters will be at the Fontana plant, where he has been works manager for the past 2½ years. Mr. McMeans joined John A. Roebling Sons Co., Trenton, N. J., in 1935, where he gained rapid promotions and was appointed superintendent of the open hearth and rolling mills division in 1942. In 1947 Mr. McMeans joined the Kaiser Steel organization as assistant general superintendent at Fontana, and in November 1948 was appointed general superintendent. In the Spring of 1950 he was made works manager.

Samuel Horelick has retired as chairman of the board of Pennsylvania Transformer Co., Canonsburg, Pa. Mr. Horelick, together with **W. E. Kerr,** formed the Pennsylvania Transformer Co. in 1929. Mr. Horelick served as president from 1929 to 1949, at which time Mr. Kerr took over the presidency and Mr. Horelick became chairman. The company merged with McGraw Electric Co., Elgin, Ill., in 1952.

Randolph W. Hyde was appointed assistant vice president and assistant treasurer of United States Steel Corp., Pittsburgh, Pa. Mr. Hyde will have authority over and coordinate all domestic credit activities throughout United States Steel Corp., including its divisions and subsidiaries engaged in mining, manufacturing and distribution activities.

G. J. Doss has been named general manager of the newly established switchboard division of Electric Products Co., Cleveland, Ohio. Mr. Doss went to Electric Products Co. in 1946 as manager of the Cleveland district office and in 1951, was advanced to assistant sales manager.

Floyd D. Hunter, a member of Youngstown Sheet and Tube Co. more than 16 years, resigned to become assistant treasurer of the Valley Mould & Iron Corp. at Hubbard, Ohio.

C. S. Beattie and **R. E. Anderson** have been elected vice presidents of H. K. Porter Co., Inc. Mr. Beattie will continue as general manager in charge of all activities of Delta-Star Electric division of the Porter company. He joined Delta-Star in 1930 and had been executive vice president of the division until his election as vice president of Porter. Mr. Anderson will continue to direct Delta-Star Electric division's sales activities and commercial relations as he has in the past. He had been senior vice president of the division until his election as vice president of the parent company.

William H. Smith and **John F. Ganey** are newly named sales representatives to the Pittsburgh, Pa., district office and the Chicago, Ill., warehouse sales unit, respectively, of Allis-Chalmers general machinery division. Mr. Smith is a 1952 electrical engineering graduate of Carnegie Institute of Technology. Mr. Ganey is a graduate electrical engineer of Marquette University and recently completed Allis-Chalmers graduate training course.

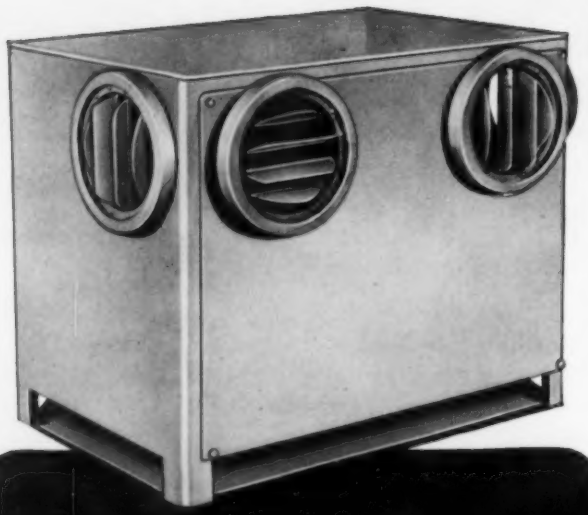
Joseph Becker, retired December 31 as vice president and general manager, engineering and construction

VAN H. LEICHLITER

DWIGHT S. EWALT

GEORGE B. McMEANS

JOSEPH BECKER



New Features Less Space

The new Lintern Crane Cab Heater, Model 53 VHG—a general purpose heater — is 15″ shorter than any previous Lintern model.

Yet it delivers 360 c.f.m., the same circulating capacity as larger units. And two other features make it ideal when heat is needed.

A new plastic tray type electrostatic filter is used in conjunction with a tray type activated carbon filter. The only maintenance required is that the plastic filter be given a cold water bath when it gets dusty. No re-oiling needed either!

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division of Koppers Co., Inc. Mr. Becker will remain however, as a consultant to Koppers and through that company as a consultant to the nation's steel industry.

GEORGE M. CARVLIN

With Mr. Becker's retirement, the election of **George M. Carvlin,** vice president and assistant general manager of the Koppers division to the post of general manager, was announced.

R. Randall Irwin has been appointed manager of personnel and industrial relations for the Brown Instruments division of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

Harry T. Milner was appointed director of personnel for National Roll and Foundry Co., Avonmore, Pa. Mr. Milner had been in industrial relations with Crucible Steel Co. and United States Steel Corp. before assuming his present position.

Robert C. Myers has been appointed director of market development of United States Steel Corp. Mr. Myers succeeds Robert J. Ritchey who is leaving to accept a position as assistant general sales manager of the Townsend Co., Beaver Falls, Pa.

LOUIS ALLIS, JR.

Louis Allis, Jr., formerly vice president in charge of sales of Louis Allis Co., Milwaukee, Wisc., has been

Now! Another *Air Products* FIRST!

Cut Costs — make your own

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OXYGEN and NITROGEN

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IF you now use both oxygen and nitrogen—or use one now and might need the other later—here's news that can save you thousands of dollars every year:

At slight extra cost, the larger models of *Air Products* High-Purity Generators can be converted to produce dry NITROGEN *simultaneously* with dry OXYGEN, both at purities to 99.9%!

You save up to 30% over any other method on your nitrogen requirements for annealing, steel making, heat treating, chemical manufacturing, packaging, etc. For higher purities—up to 99.99%—all you need is one piece of auxiliary equipment!

And You Still Get All the Savings of Making Your Own Oxygen...

. . . by eliminating transportation costs, handling costs, vaporizing costs, evaporation losses, residual losses, down-time due to delivery failures or shortages, etc. *Air Products* Generators take oxygen out of the *free* air, and deliver it *at any desired pressure.*

With an *Air Products* Generator, you know you are getting practical, proven equipment. Over *450* have already been put into successful operation. This experience has shown that oxygen-nitrogen generators must be simple, trouble-free and require very little maintenance. That's why *Air Products* standard Generators do not use complicated air-cleaning systems, and need *no* tricky oxygen compressors as necessary additional equipment.

Write us your requirements, or

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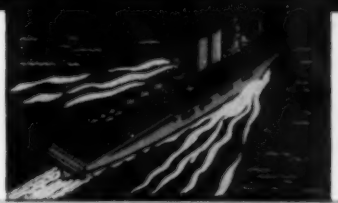
FIRST *Air Products* was the first to make an oxygen generator that could be transported by truck.



FIRST *Air Products* was the first to make an oxygen generator that could be operated aboard ship.

FIRST *Air Products* invented the liquid pump for the delivery of high pressure oxygen and/or nitrogen.

FIRST An *Air Products* Generator was the first to be installed in a hospital for medical oxygen production.

elected a vice president of the company. **C. G. Skidmore,** formerly sales manager of the company, was appointed vice president in charge of sales.

C. G. SKIDMORE

R. G. Schrock was elected to the position of executive vice president of Euclid Electric and Manufacturing Co., Madison, Ohio.

James B. Shea was elected president of Furnace Engineers, Inc., Pittsburgh, Pa., succeeding the late Harry Dobrin. **C. R. McCloskey** was elected executive vice president.

Van N. Marker has retired as president of Revere Electric Manufacturing Co., Chicago, Ill., effective December 31, 1952. **Murray Whitfield,** executive vice president and sales manager, will assume the presidency and succeed Mr. Marker in the management of the company.

Albert L. Hunt was named manager of industrial sales for National Bearing division of American Brake Shoe Co., St. Louis, Mo. Mr. Hunt, who joined National Bearing in 1936, was appointed plant superintendent at St. Louis in 1942, and general superintendent of foundries for the division in 1952. He will continue to be located at division headquarters in St. Louis.

Warren G. Rosendahl has been recently appointed director of manufacturing for the Columbia Machinery and Engineering Corp., Hamilton, Ohio. Mr. Rosendahl joins Columbia after recently serving as assistant general manager of the Hamilton division of the Clearing Machine Corp.

John E. Angst, sales agent for the American Car and Foundry Co., in Chicago, Ill., has been appointed assistant western sales manager.

H. L. Richardson has been named divisional sales manager to head the newly established office of Research Corp. in Pittsburgh, Pa. Mr. Richardson will be located

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IN spite of the best of operating practice, blast furnace copper castings and steel mill bronzes wear out and must be replaced and replaced QUICKLY!

Blast furnace and steel mill new construction projects require copper and bronze castings ON SCHEDULE.

Your experience has convinced you that *you can expect immediate* and *scheduled* deliveries of QUALITY copper and bronze castings from THE FALCON BRONZE COMPANY.

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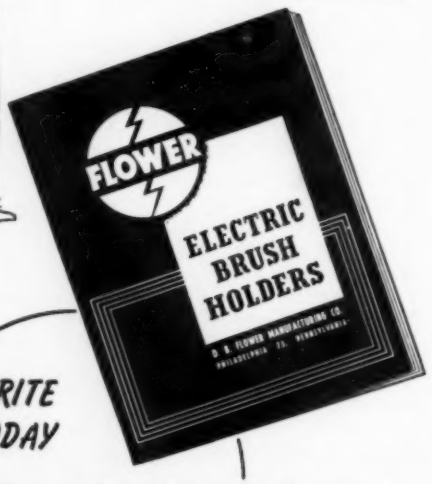

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1217 SPRING GARDEN ST., PHILA. 23, PA.

in the Grant Building and will cover the western section of Pennsylvania and the state of West Virginia. In addition to sales activities, the new office will also handle all engineering services in the area. Mr. Richardson joined Research Corp. in 1936 and has spent considerable time in the Pittsburgh area in both sales and engineering capacities.

James S. McCullough assumed charge of sales promotion for the industrial division of Gould-National Batteries, Inc., whose sales offices are at Trenton, N. J. Mr. McCullough formerly directed advertising for the industrial truck division of Yale & Towne Mfg. Co., and recently resigned as advertising and sales promotion manager of Lamson Corp.

Fred C. Timberman has been appointed manager of a newly established Akron, Ohio, branch of the Cleveland district office of Allis-Chalmers, general machinery division. The new office is located in the First National Tower in Akron. Mr. Timberman has been a sales representative in Allis-Chalmers Cleveland district office for more than 10 years. **Donald W. Ganzhorn** has been assigned as representative in the new Akron branch office.

John P. Coakley was named eastern sales manager of the engineering works division of Dravo Corp. Mr. Coakley's headquarters will be at the corporation's offices at 30 Church Street, New York, N. Y.

Jack E. Reilly has joined the industry engineering department of Elliott Co. This department is maintaining offices at 715 Frick Building, Pittsburgh, Pa.

E. E. McVeigh has been named manager of commercial sales for Baker-Raulang Co., Cleveland, Ohio, with the responsibility of directing all dealer activities in Baker's western division, and the supervision of application engineering projects involving western division users and prospects. **R. T. Tiebout** was named manager of government sales. He will represent Baker-Raulang in its negotiations with all branches of the government.

Raymon Manson Eaton, superintendent and resident manager of the Hazard Insulated Wire Works division of Okonite Co. in Wilkes-Barre, Pa., retired December 31, 1952 after 43 years' service.

Wilbert G. Prasse was elected president of the Oilgear Co., Milwaukee, Wisc. to succeed the late **Goerge H. Fobian.** Mr. Prasse was appointed eastern sales representative in 1928, general sales manager in 1941 and vice president and director in 1945. **Frank G. Kuhagen** was elected vice president.

(*Please turn to page 210*)

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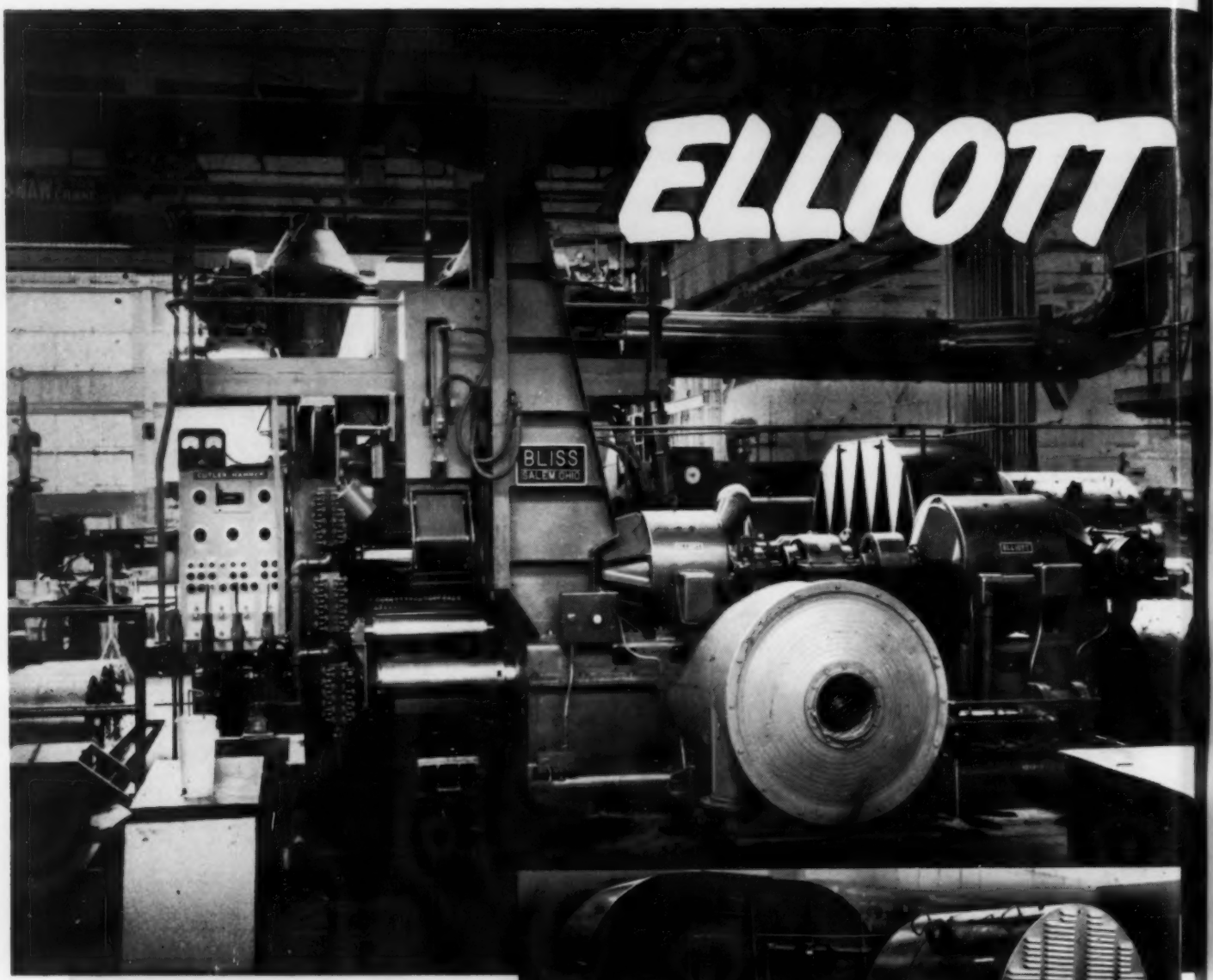
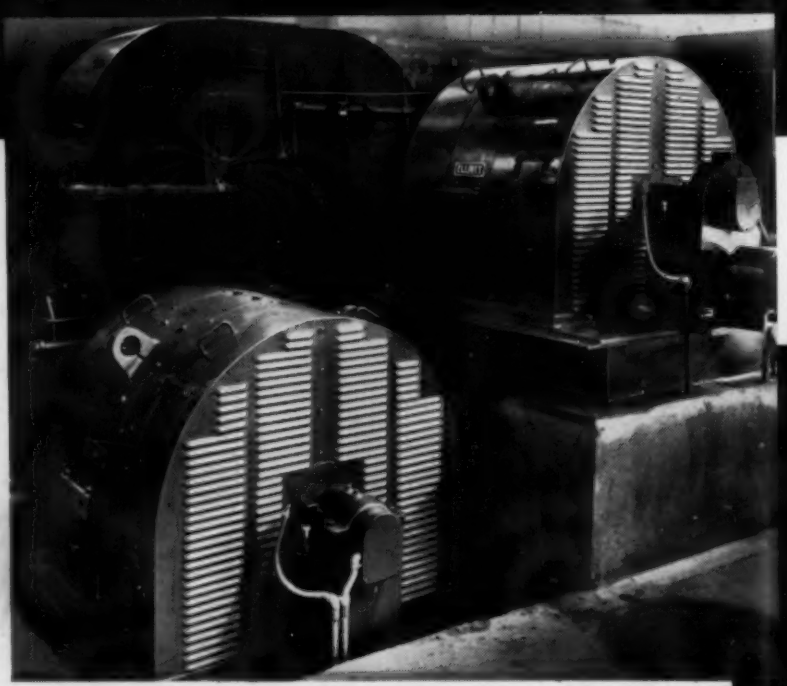


Delivery end of mill, with Elliott 20-hp and 75-hp, 300/1200-rpm reel motors in tandem at right, for adjustable tension on heavy and light strip. Duplicate motors drive reel at opposite end of mill.



Twin drive for mill back-up rolls ▶ with two Elliott 300-hp, 450/900-rpm motors. All machines are designed for fast acceleration and deceleration.

Elliott five-unit 740-kw generator set provides adjustable ▶ voltage power for mill motors and reel motors. Ventilating equipment in background. All machines are force-ventilated.

motors and generators

...drive four new reversing cold strip mills for Revere Copper and Brass Incorporated

● In these important installations, Elliott supplied not only the adjustable-voltage main drive motors for the four new mills, but also motors for constant-voltage auxiliary drives such as lube drive, screwdown, reel traverse, air-wipe blower, buggyhoist, and roll changer.

Control is Cutler-Hammer, developed in close cooperation with Elliott engineers.

An article giving details of these installations, involving mills designed for rolling brass and copper strips in coils weighing up to 5000 lb. at a mill speed of 500-1000 ft. per min. was published in the Winter issue of our quarterly magazine, POWERFAX. Copies can be obtained from your nearest Elliott Company district office or write direct to Advertising Department, Elliott Company, Jeannette, Pa.

ELLIOTT Company

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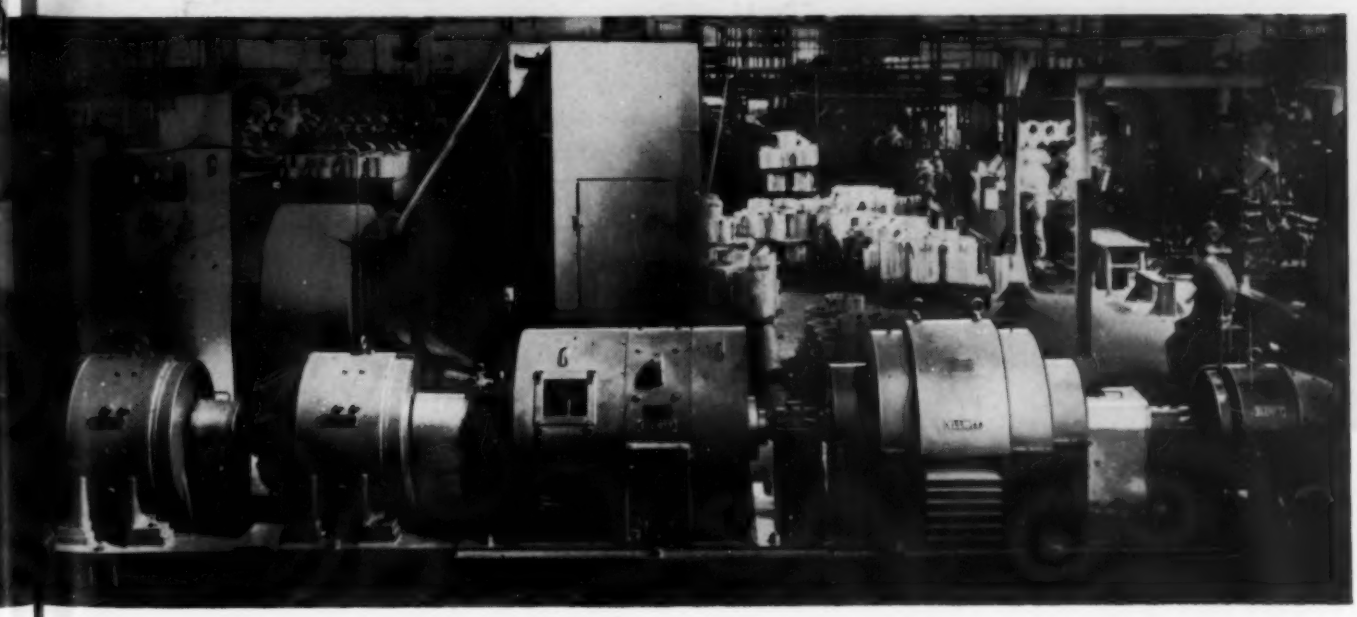


R3-4

Arthur C. Burke, superintendent of the rolling mill department of the Steelton, Pa. plant of Bethlehem Steel Co. has retired, and **Russell M. Weigle** was appointed to take his place. Mr. Burke's career with Bethlehem dates from June, 1909, when he entered the employ of Pennsylvania Steel Co., at Steelton, as a clerk in the order department. When Bethlehem acquired Pennsylvania Steel in 1916, Mr. Burke continued his employment with the new owner. He became superintendent of rolling mills November 1, 1947. Mr. Weigle started with Bethlehem at the Danville, Pa. plant as an electrician helper. When Danville was closed he was transferred to Steelton. He became assistant superintendent of rolling mills, his current position, on November 1, 1947.

John M. Van Winkle has retired as president of Post-Glover Electric Co., Cincinnati, Ohio. New officers are as follows: **Clarence E. Nuckels,** president; **Marvin A. DuBois,** vice president in charge of engineering; **Thomas R. Gano,** vice president in charge of sales; **Edward A. Vosmer, Jr.,** secretary and treasurer; **Joseph H. Thiem,** elected to the board of directors; and, **Robert W. Houp,** appointed sales manager.

Joseph P. Charlton was appointed superintendent of the blooming mills at Central-Canton district of Republic Steel Corp., Canton, Ohio, succeeding **Lowell M. Immel** who recently was named superintendent of the Canton steel division. **Peter T. Reynolds,** became assistant superintendent of the blooming, billet, and bar mills, Central-Massillon, succeeding Mr. Charlton. **E. Ernest Weatherbee** succeeds Mr. Reynolds as roll designer at Massillon. Born in Canada, Mr. Weatherbee was roll shop foreman at the Massillon plant for three years prior to his new appointment.

W. E. Hess has been appointed manager of coal mines for Jones & Laughlin Steel Corp. Formerly general superintendent of coal mines, Mr. Hess will be responsible for operation of the Vesta-Shannopin Coal division, California, Pa., and the Twin Branch-Black Eagle Coal division, Twin Branch, W. Va.

John T. Kemper was appointed manager of the Boston, Mass., electrical division office of Wagner Electric Corp., succeeding **M. E. Comstock,** who is retiring after nearly 34 years' service to the company. Since 1941, Mr. Kemper served as a field engineer in the Pittsburgh, Pa., office until 1946 when he was transferred to Boston.

Robert Guelcher was appointed industrial engineer by the Ajax Flexible Coupling Co., Inc., Westfield, N. Y. Mr. Guelcher was formerly assistant works manager of Uniflow Manufacturing Co., Erie, Pa.

J. S. Smith has been appointed director of purchases and production planning for Wagner Electric Corp., St. Louis, Mo., with responsibility for purchasing policy, trade relations, and the coordination of production planning. **H. S. Garrett** is now purchasing agent with full responsibility for the administration of purchasing activities.

W. G. Miller has been appointed superintendent of the transportation and labor department at Republic Steel Corp., Buffalo, N. Y., succeeding **W. B. Caylor,** who has retired. **J. B. Hunley** has been appointed assistant superintendent of the transportation and labor department, succeeding Mr. Miller.

T. M. Girdler, Jr. has been named to the position of assistant manager of operations for Republic's Union Drawn Steel division at Massillon, Ohio. Prior to the new appointment Mr. Girdler was superintendent of Union Drawn's Beaver Falls, Pa., plant. He will move to the division's headquarters at Massillon. **Horace B. Anderson,** who has been assistant superintendent of Union Drawn's Massillon plant, succeeds Mr. Girdler at Beaver Falls. **Harry B. Matzen, Jr.,** an industrial engineer at Massillon, succeeds Mr. Anderson as assistant superintendent at the Massillon plant.

William Stahly was named manager of Armco Steel Corp.'s tubing division at Piqua, Ohio. Mr. Stahly succeeds S. E. Jackson, present manager of the tubing

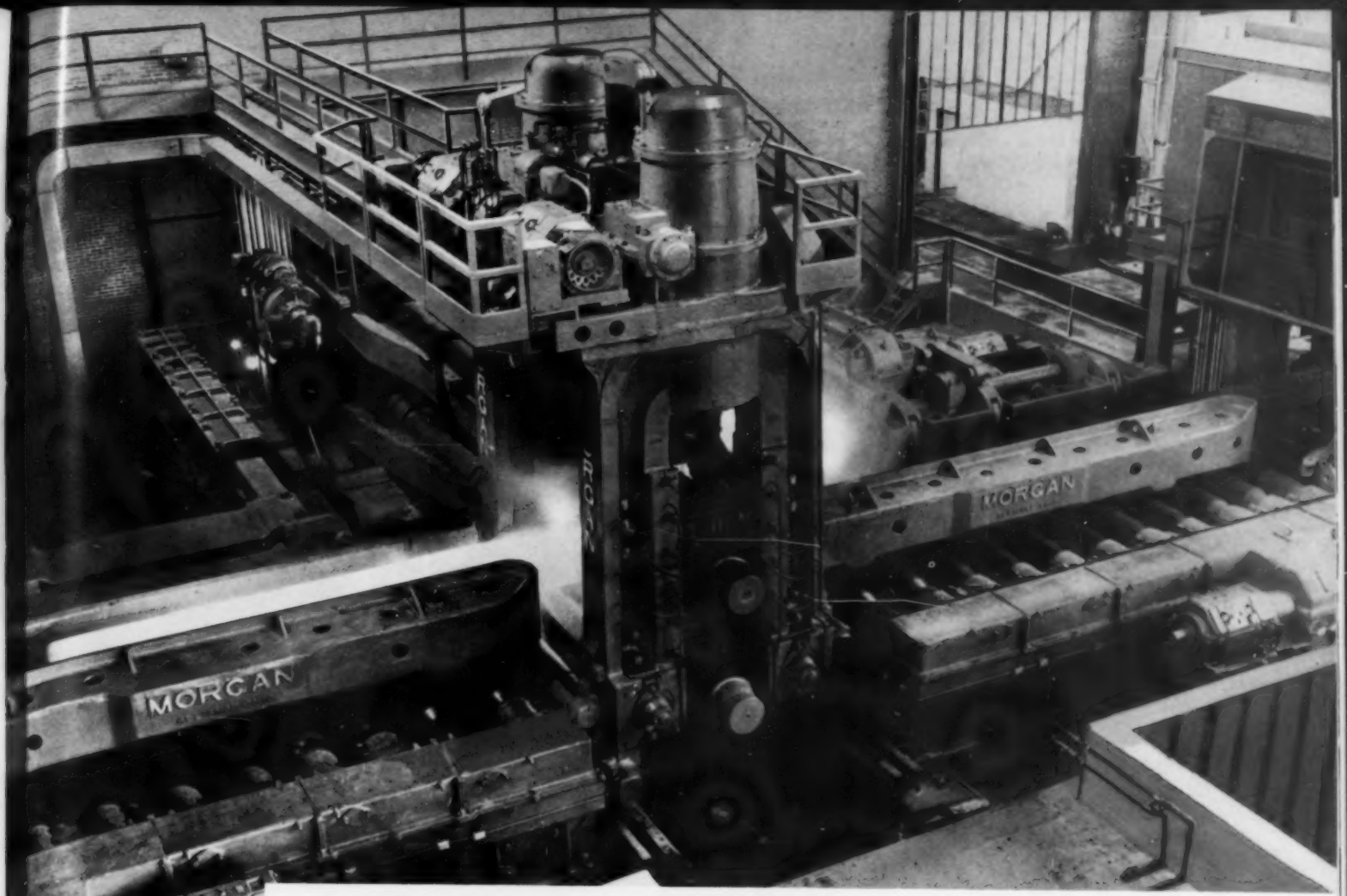
WILLIAM STAHLY

division, who resigned December 1, because of ill health. Until his new appointment Mr. Stahly was chief engineer and superintendent of maintenance of the tubing division.

Wylie Brown has been elected a director and chairman of the board of Hydropress, Inc., New York, N. Y. Mr. Brown retired last year as chairman of the board of Phelps Dodge Copper Products Corp., a company he had headed for many years.

Wilbur F. Koester has been named manager of the plant engineering department of Allis-Chalmers general machinery division, Milwaukee, Wisc. The new department has the responsibility of over-all coordinating and general supervision of plant engineering for the company's eight general machinery division plants.

(*Please turn to page 214*)



A Modern 40" two-high Blooming Mill with Twin Motor Drive

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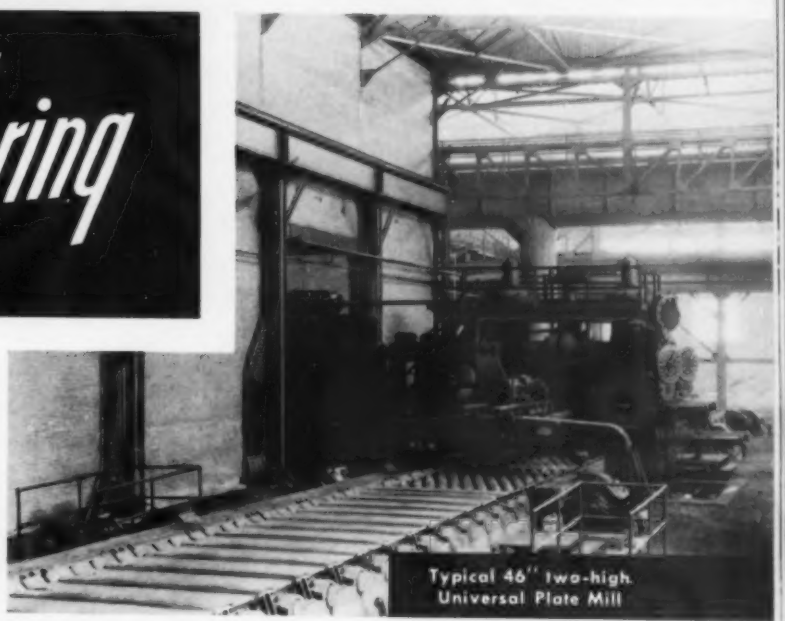
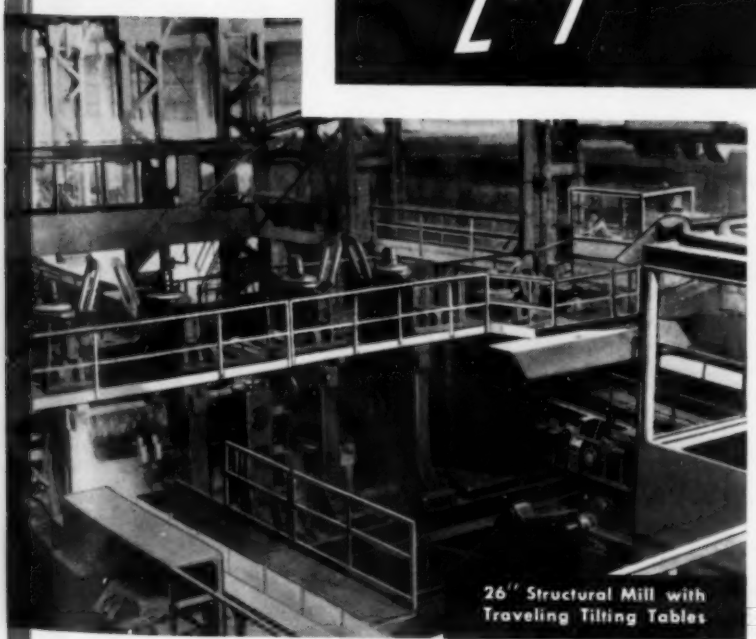


Typical 46" two-high Universal Plate Mill



26" Structural Mill with Traveling Tilting Tables

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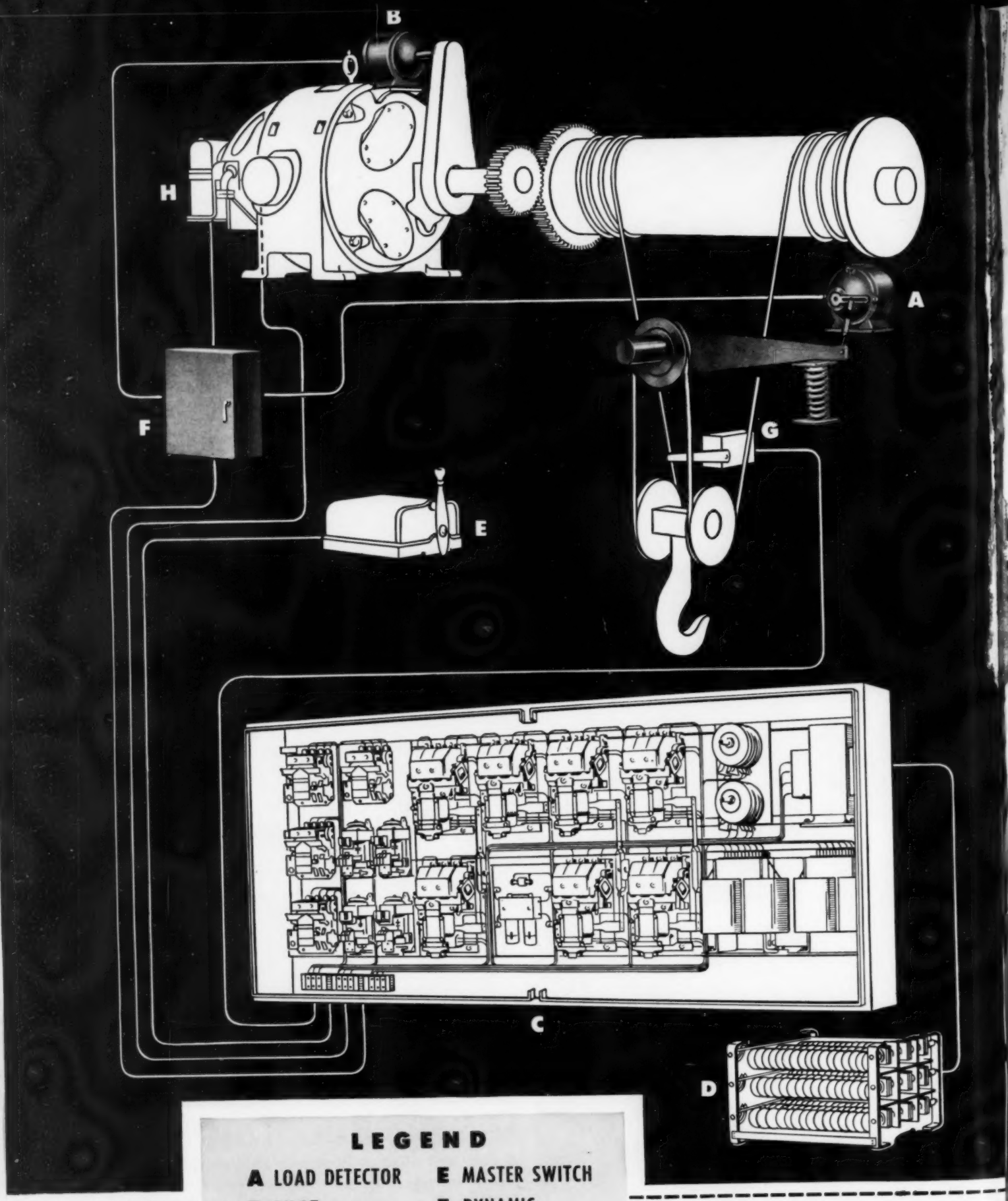

LEGEND

- **A** LOAD DETECTOR
- **B** PILOT GENERATOR
- **C** MAGNETIC CONTROLLER
- **D** RESISTOR
- **E** MASTER SWITCH
- **F** DYNAMIC BRAKING UNIT
- **G** LIMIT SWITCH
- **H** HOLDING BRAKE

NEW LOAD-O-MATIC

A-C CRANE HOIST CONTROL

Here's the new Westinghouse Load-O-Matic Crane Hoist Control that divorces torque from speed and permits the co-ordination of speed and load to suit the requirements of each particular installation.

Key is the Automatic Load Detector shown on the schematic drawing at the left. This mechanism measures the weight of the load suspended on the hook and, through the medium of the main circuit, uses this intelligence to control the power delivered to the hoist motor. Thus, motor torque depends primarily on hook load.

This means—*precise crane performance.* Loads can be accurately spotted without the necessity of jogging or inching. Operator can actually float the load into the desired spot. Overshooting is eliminated. Crane operation can be delegated to semi-skilled operators.

Load-O-Matic offers you these exclusive features:

SLOWER STABILIZED CREEPING SPEED throughout the load range than for any other a-c system.

DECREASE IN SPEED WITH INCREASE OF LOAD on first two points, hoist and lower—safer and surer handling.

MINIMUM MOTOR SIZE for a given crane—less motor input current is required than for any other electrical braking system.

DYNAMIC BRAKING to prevent dropping of load in case of power or brake failure.

LOAD DETECTOR PREVENTS LIFTING EXCESSIVE LOADS by operating signal or by shutting off power.

LONGER CONTACTOR LIFE—saturable reactor excitation gives speed control for positioning . . . fewer contactor operations. J-27014-A

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Lee Sekulski, sales manager, Mathews Conveyor Co., Ellwood City, Pa., has been elected a director of the Conveyor Equipment Manufacturers Association.

Gerald E. Smart, a plant engineer at Allis-Chalmers Norwood, Ohio, works since January, 1951, has been placed in charge of the plant engineering department there.

Irvin L. Clymer, president of the Michigan Limestone division of U. S. Steel Corp., Detroit, Mich. retired on December 31, 1952, **Hugh Sutherland Lewis,** who has been executive vice president of the division, succeeded Mr. Clymer.

R. J. S. Pigott, director of engineering, Gulf Research & Development Co., Pittsburgh, Pa., has retired from that position. Mr. Pigott will continue in the capacity of consultant.

Woodrow W. Oliver was named Cleveland district purchasing agent of American Steel & Wire division of U. S. Steel Corp., Cleveland, Ohio, succeeding **Otto C. Langenhan,** who retired November 30 after 45 years of service in the purchasing field. Mr. Oliver comes to his new post from Worcester, Mass., where he has served for two years as eastern district purchasing agent for the division. Named to succeed him in that post was **Elmer R. Johnson,** assistant district purchasing agent at Worcester.

John Cullen was appointed superintendent of yards, roads and transportation at Kaiser Steel Corp., Fontana, Calif., works. Mr. Cullen went to the Fontana plant in 1949 from Kaiser's Sunnyside coal mines, Utah, where he had been underground superintendent. At Fontana he was field traffic representative and later, assistant superintendent of yards, roads and transportation.

C. Howard Paul, secretary and treasurer of Mackintosh-Hemphill Co., Pittsburgh, Pa., has been elected a vice president of the corporation. He joined the firm in 1917 and became comptroller in 1924. Mr. Paul was named assistant secretary-treasurer in 1929 and became secretary and treasurer in 1936. He has been a member of the board of directors since 1944.

Edward M. Norton has been named administrative assistant to the manager at the Butler, Pa., plant of Armco Steel Corp. **Frank Burdette** was appointed superintendent of the processing department, and **Joseph C. Slater** succeeds him as superintendent of the strip coating and silicon department.

Obituaries

Warren S. Hall, past president of the Association of Iron and Steel Engineers for the year 1922, died November 3, 1952. Mr. Hall, a former chief engineer

WARREN S. HALL

of the Chicago district of Carnegie-Illinois Steel Corp., was most recently associated with United Engineers and Constructors, Inc., as a consultant.

John A. Ingwersen, vice president in charge of distribution, Armco Steel Corp., died December 5 in Middletown, Ohio.

Joseph Kent Harrison, Sr., 74, died at his home in Butler, Pa., on December 20. During his long career Mr. Harrison served as open hearth superintendent at the Ashland, Ky., and Butler, Pa., plants of Armco Steel Corp. He retired in 1945.

Dr. John L. Bray, 62, professor of metallurgy on the Purdue University staff since 1923, and head of the school of chemical and metallurgical engineering from 1935 to 1947, died at his home in West Lafayette, Ind., on December 6.

Frank L. Estep, 76, a consulting engineer for more than half a century, died December 18 in New York, N. Y. Mr. Estep was born in Jeffersonville, Ohio, and studied at Ohio State University. At his death, he was a consultant to the Barium Steel Corp., the Cia Fundidora de Fierro of Mexico and Birla Brothers of India. He had served with Perin & Marshall, consulting engineers, and had been architect-engineer for the Defense Plant Corp. in New York, and chief engineer for the Tennessee Coal, Iron and Railroad Co., of Birmingham, Ala.

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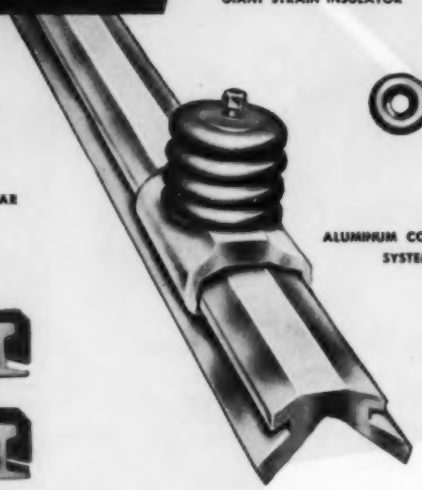
PORCELAIN INSULATOR

GIANT STRAIN INSULATOR

INSULATED EYE BOLT

TROLLEY WIRE EAR


ALUMINUM CONDUCTOR SYSTEM

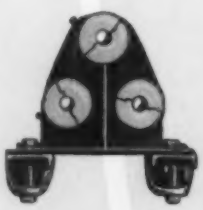
TROLLEY WIRE SUSPENSION

CABLE STRAIN CLAMP

SUPPORTING STANDARD

CABLE RACK

ANGLE CONDUCTOR SUPPORT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JANUARY, 1953

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(1) Meehanite Metals

"Proof that Meehanite Bridges the Gap Between Cast Iron and Steel" is the title of a new 20-page booklet which has been published. The booklet which is well illustrated is devoted to a series of case histories showing how in recent months critical material shortages have been solved by the use of Meehanite castings. Also included are alphabetical tabulations showing specific replacements of alloyed irons and steels, brass, bronze, forgings and so forth. The type of Meehanite metal used for such applications is also provided. (37). Meehanite Metal Corp.

(2) Industrial Lighting

The latest and most elaborate of a series of "See Better — Work Better" bulletins, designed to promote improved lighting in the nation's industrial plants, has been issued. The publication describes what it calls the "revolution in industrial lighting." This revolution, it states, is based on the concept of balanced brightness, as well as sufficient light, over the entire work area. Benefits are listed as better workmanship, faster output, reduced spoilage, fewer accidents, and improved employee morale. Headings of the bulletin's various sections are: "Here's What Is Happening to Industrial Lighting," "New Era in Lighting Fixtures," "Comfortable Working Environments Pay off," "Another Look at the New Look," "The Revolution Applies to All Plant Areas," and "The Role of G-E Lamp Research." (8). Inquiry Bureau, General Electric Co. (Nela Park).

(3) Materials Handling

A new bulletin is available that describes the "Pak-Loader" system for handling materials in unit loads without the use of pallets. Using a special steel plate and a fork truck equipped with a pusher attachment, this system provides all the advantages of palletized handling without the need for an investment in pallets. Loading is accomplished by having the fork truck push the plate under the load, thereby eliminating all manual handling. When using this method, the truck deposits the plate in front of the load. The truck then backs away and raises the forks to clear load. With forks raised above the load, the truck pushes the plate under the load with the vertical channels as the truck moves forward. The unloaded plate can be picked up as easily as a standard pallet. To unload, a special gripper holds the plate while the load is being pushed off. (P-1173-A.) Yale & Towne Manufacturing Co.

(4) Industrial Maintenance

"Industrial Maintenance" is the title of a new booklet available to you. The booklet details such vital topics as "How To Keep Equipment, Methods and Facilities In Top Operating Condition"; "A Guide To Organizing An Industrial Maintenance Program"; "Check List For Machinery"; "Maintenance Of Methods"; "Plant Facilities"; and "Physical Environment." In addition, the literature covers the features of lighting, air conditioning, color painting, noise conditioning, vibration control, plant architecture and good housekeeping. You can also get the details of employee operating efficiency, worker health and comfort, and employee morale. A highly valuable maintenance check list is designed to aid in evaluating a company's existing maintenance program. Wheeler Associates, Inc.

(5) Self-Cleaning Strainers

Available for distribution is a new 12 page booklet containing the latest information on Kinney and Brassert line of strainers. Complete descriptions, illustrations, diagrams, and pertinent engineering data are included regarding the Brassert automatic self-cleaning strainer, the Kinney automatic self-cleaning strainer, and the Kinney manually operated self-cleaning strainer. These strainers are constructed in 2 in. to 36 in. sizes and are applicable for steel mill and other industrial uses. S. P. Kinney Engineers, Inc.

(6) Industrial Truck Attachments

How to increase the efficiency of your powered industrial trucks is the theme of a two-color booklet. According to the manufacturer, the use of various types of specially designed attachments enables one truck to do the job of many, thereby increasing economy of operation, plus greatly increasing its range of applications. More than 25 of these attachments are illustrated and described including: revolving forks, roll paper clamp, hook & boom, electromagnet, ladle pourer, remote control, upender, scoop, clamps, and many others. Each type of attachment is pictured and is accompanied with detailed text of its design and applications. The literature is designed for quick and easy reference by material handling engineers, production personnel, supervisors, purchasing agents, etc. (B-329). Elwell-Parker Electric Co.

(7) Publication Index

Available to you is a convenient index of Westinghouse publications concerning equipment for the steel industry. It is a ready reference to Westinghouse apparatus booklets, buying data, and technical article reprints which you may obtain by using the return postcard attached to the folder. Westinghouse Electric Corp.

(8) Dust Collection

Dust collection in the mining and metallurgical industries is the subject of a new bulletin just published. Case histories are given in this 8-page, illustrated brochure which show how Dustube cloth-tube-type collectors are used in filtering gases from such equipment as lead blast furnaces, sintering machines, and cupolas melting slag. Other applications presented include dust control in dross

sampling, coal cleaning and asbestos processing. Also discussed is the roll of synthetic fabrics in the filtration of hot or corrosive gases. (402). American Wheelabrator & Equipment Corp.

(9) Control Center Booklet

A new 31-page application booklet on control centers is available. Stressing the case for centralizing all controls of an entire system in one group of enclosures, this booklet discusses the characteristics of control centers that make for flexibility of application, ease of servicing, and safety of operating personnel. Three types of control centers are described, and the various electrical components that make up typical units are illustrated and defined. A three-step building-block system of planning control centers is given, along with check charts to aid the selection of the right control center arrangement. Reference tables for proper selection of starter size are provided. Addresses of fifteen Westinghouse manufacturing and repair plants that manufacture and service control centers are listed. Analyses are made at these locations by competent engineers, at field level, of the control requirements of the particular machine or application. (B-5621). Westinghouse Electric Corp.

(10) Lightweight Coupling

A leaflet is available that gives full information on an entirely new development in shaft couplings that has just been introduced. This new, economical, light weight gear coupling can be used for the smallest fractional horsepower drives. The same major construction features of the modern gear type couplings so widely used for larger units is now available for nominal bores down to 3/8-in. diameter. John Waldron Corp.

(11) Pneumatic Butterfly Valves

A bulletin is available that describes butterfly valves designed to regulate the flow of air, gas, liquids or steam in conjunction with indicating, recording or non-indicating pneumatic controllers. The bulletin contains application data, specifications, dimensions, sizing data. (8503). Brown Instruments Division, Minneapolis-Honeywell Regulator Co.

(12) Weldment Assemblies

Fabricated steel weldments; composite welded assemblies of fabricated steel plate and castings; and cast-welds assembled entirely of castings, is the subject of a new 6-page bulletin just issued. The bulletin also describes the physical advantages of weldments, design principles, economy factors and Continental's facilities for this production. Continental Foundry & Machine Co.

(13) D-C Mill Motor

Westinghouse has put more than half a century of mill motor design and experience into the development of each component part of the new "Hevi-Duty" d-c mill motor. The new 600 series mill motor is exactly what the users requested as Westinghouse made an extensive canvass to obtain information on what industry wanted incorporated in a new design. Ruggedness, compactness, dependability, simplicity and ease of maintenance were demanded. Then, with these features in mind, the engineers went to work incorporating all of these features in the design and built the new 600 series mill motor to AISE specifications. This publication, B-5791 "Hevi-Duty DC Mill Motor" shows how this design utilizes space within the frame to the nth degree. How its high starting torque makes it ideal for high inertia loads . . . improved commutation, and all the other features which go to make up a brand-new motor with a new kind of performance built for today's tougher job. Westinghouse Electric Corp.

(14) Manual Magnetic Disconnect Switch

A new bulletin describes the new EC&M manual-magnetic disconnect switch for lifting magnets. These disconnects bring new safety for equipment and for men. Unlike previous disconnect means, these new switches not only have high interrupting capacity, but also establish a discharge path if they are opened with the magnet energized. (906). Electric Controller and Manufacturing Co.

(15) Electrode Rapping System

A new 6-page bulletin with illustrated information on the recently developed magnetic impulse continuous electrode rapping system for electrostatic precipitators, has been announced. The rapping system is a continuous, self-monitoring electrode cleaning system that improves overall precipitator efficiency and reduces operating costs. Operation of this system is explained, with circuit diagrams and photographs of major components, in the new bulletin, which also contains a summary of exclusive rapper features. (MI). Research Corp.

(16) Magnetic Ideas

A "one-a-month" information kit describing permanent magnet application ideas for industry has been announced by the Carboloy Department of General Electric Co. The basic "kit" consists of a heavy permanent binder with six application ideas, each described on a separate loose leaf page. Each month the department plans to issue a new magnet application sheet which will be distributed automatically to those who request the basic information kit. The first six ideas presented are: use of magnets on conveyors to transport ferrous parts, sheet steel separators, floor sweepers to pick up ferrous objects, plant layouts, tool racks, and shear tables for cutting sheet metal. Each idea sheet contains complete technical information and diagrams regarding the particular application described. To obtain the first kit and subsequent publications circle No. 16 below.

(17) Dis-Ruptor Switch

A bulletin has been released that describes a new dis-ruptor switch for 600 volt a-c or d-c service that combines the functions of disconnect and load interrupter. Three switches are shown, also catalog numbers for the entire line. With its exclusive arc-ruptor chamber and quick-make, quick-break mechanism, the Delta-Star "Disruptor" offers safe positive load interruption. Used with "Amptrap" fuses, the switch combines both fault protection and high interrupting capacity. (5208). Delta-Star Electric Division, H. K. Porter Co., Inc.

(18) Silicone Electrical Insulation

Engineers learn young to discount claims that sound fantastic. That's healthy skepticism, but it sometimes delays acceptance of the most revolutionary new developments. Take silicone (Class H) electrical insulation, for example. Three years ago conclusions were published based on six years of accelerated life testing. Those tests indicated that silicone (Class H) insulation has a temperature advantage of about 100 C, and a life expectancy of 10 to 100 times the life of the next best class of electrical insulation. That kind of heat stability could also be used

to increase the power per pound ratio in electric machines by 50 per cent or more. Those conclusions sounded extravagant, but they have been confirmed many times by the actual performance of thousands of silicone insulated motors in almost every industry. Annual savings in motor maintenance and down-time are now estimated at millions of dollars. Potential savings are much greater. Condensed in a new booklet are some of the reports received on operating conditions and the performance of Class H insulated equipment. Also included is data on a motor test program and typical properties of Class H components. Dow Corning Corp.

(19) Eighty Test Methods

Eighty different methods for testing, inspecting, and analyzing some ninety different types of products are listed in a new folder being distributed. Prepared to show industry and business the scope of services available to them for the quality control of many products, several methods are touched on briefly, such as nondestructive testing; testing for performance corrosion resistance, protective coatings; chemical analysis; development of specifications; product certification; and the seal of approval. Emphasis is placed on the facilities that make it possible to perform many of these services in the field, in the client's plant or at the laboratories of American Standard's Testing Bureau, Inc.

(20) Control Panels

The engineering and economical planning of modern combustion and process control panels is discussed in a new bulletin. Numerous panel designs, fashioned for control, are illustrated along with the most up-to-date methods of tubing and wiring. A section on panel accessories of utility and appeal combine to make a valuable source book of ideas for control station planners. (170) Bailey Meter Co.

(21) Cold Cleaners

Industrial metal cleaning can be streamlined into a low cost but highly efficient process with the aid of "cold cleaners" recently developed. This is described in a leaflet available to you. Used at room temperature in power washers, the new "Houghto-Clean 439 and 440" combination effectively removes such soil as heavy drawing oils, pigmented drawing compounds, sulphurized cutting oils, rust preventives, and polar type smuts from ferrous metals, copper and brass. Because no heat is required, this cold cleaning team lowers operating and maintenance costs. Steam lines, ventilators, stacks, exhaust fans, etc., can be eliminated. As there is no steam or toxic "mist" involved, these Houghton products also help improve shop conditions. Other advantages proven in use are: long lasting stability which provides extra economy; protection against rust; simplicity of preparation and use. The room-temperature solution of Houghto-Clean 439 and 440 produces a soil-free surface on all metal parts. E. F. Houghton & Co.

(22) Product Directory

A very complete directory of the products of Link-Belt Co. is available. This directory lists the products grouped as to chains, drives, transmission products, conveyors, auxiliary products and shovel-cranes, also the catalogs available. Also described are the industries served, the research and engineering facilities available, the manufacturing plants, distributors, and personnel. (2453). Link-Belt Co.

(23) Electric Traveling Cranes

A complete catalog is available describing Shaw Box Series D "Load Lifter" double girder electric traveling cranes. These cranes, according to the publication, make available for average industrial service, a line of cranes from 1 to 20 ton capacity at prices much less than previously asked for cranes of like capacity and for similar service. (221). Manning, Maxwell and Moore, Inc., Shaw-Box Crane and Hoist Division.

(24) Carbide Tooling

The step-by-step progress of the development of carbide tooling for the steel industry is given in a new booklet just published. In 1946 Kennametal, Inc., considered the problems of the iron and steel makers on an industry-wide basis. It was found necessary to demonstrate that Kennametal cemented carbide tooling could stand the gaff of cutting metals of high scleroscope hardness at comparatively low speeds, do it on available equipment, and substantially reduce machining costs. The result of this pioneering is shown in the booklet—today these tools are successfully used in leading mills on existing equipment, and new equipment is being produced that will make even greater use of the material's inherent benefits.

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52	AMERICAN AIR FILTER CO., INC.	BULLETIN 241	Multi-duty automatic air filter.
53	AMERICAN MANGANESE STEEL DIVISION, AMERICAN BRAKE SHOE CO.	CATALOG WA-77	Amsco Manganese steel weldments and hardfacing selector guide.
54	BAILEY CO., WILLIAM M		Bailey pug mills.
55	BLISS CO., E. W.	BULLETIN 40	Rolling mills and accessories.
56	BROWNING & CO., INC., VICTOR R.	BULLETIN "E"	Browning mill type cranes.
57	BUSSMANN MANUFACTURING CO.		Fusetron dual-element fuses.
58	DREVER CO.		Drever roller-hearth furnaces.
59	ELECTRIC CONTROLLER & MFG. CO.	BULLETIN 1032	Youngstown limit stop.
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61	FOOTE BROS. GEAR AND MACHINE CORP.	BULLETIN HGB	Foote Bros. hygrade worm gear drives.
62	FOXBORO CO.	BULLETIN 407 AND ENGINEERING DATA SHEET 330-1	Moisture control for furnace air blast.
63	GENERAL ELECTRIC CO.	BULLETINS GEA-5332, GEA-5426, GEA-5817	G-E synchronous motors.
64	GENERAL ELECTRIC CO.	BULLETIN GEA-4654	G-E d-c mill motors.
65	HOMESTEAD VALVE MANUFACTURING CO.	VALVE REFERENCE BOOK NO. 32	Homestead valves.
66	IDEAL INDUSTRIES, INC.		Commutator and slip ring maintenance.
67	JOHNS-MANVILLE	BROCHURE PK-46A	Clipper seals.
68	JOY MANUFACTURING CO.	BULLETIN B41	Plugs and receptacles.
69	KOPPERS CO., INC., FAST'S COUPLING DEPT.		Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.
70	LEEDS AND NORTHRUP CO.	CATALOG ND46(1)	Describes the speedomax.
71	LOVEJOY FLEXIBLE COUPLING CO.		Lovejoy flexible couplings.
72	MINNEAPOLIS-HONEYWELL REGULATOR CO., INDUSTRIAL DIVISION	CATALOG 1530	ElectroniK controllers.
73	MORGAN ENGINEERING CO.	BULLETIN 16-A	Heavy duty mills and their auxiliary equipment.
74	OKONITE CO.	BULLETIN IS-1053	Okolite-Okoprene cables.
75	PACIFIC PUMPS, INC.	BULLETINS 104 AND 106	High pressure pumping.
76	PENNSYLVANIA TRANSFORMER CO.	BOOKLET NO. 522	Economics of Transformer cooling.
77	POST-GLOVER ELECTRIC CO.	BULLETIN 500	P-G limit switch resistors.
78	SQUARE D CO.	BULLETIN 8536	Motor starter.
79	TRABON ENGINEERING CORP.	BULLETIN 529	Trabon automatic lubrication system.
80	WAGNER ELECTRIC CORP.	BULLETIN IU-36	Wagner powered hydraulic braking.
81	WALDRON CORP., JOHN		Catalog available on Waldron gear couplings.
82	WESTINGHOUSE ELECTRIC CORP.	BOOKLET B-5468	Magamp regulator.
83	WESTINGHOUSE ELECTRIC CORP.		Booklet on the Westinghouse Load-O-Matic a-c crane hoist control.

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"she might have been my kid..."

"There was no time to stop, see? She comes running out from behind this parked car right under my wheels. Her hair is in pigtails, and with the sun shining on it, she might have been *my* kid. We got her to the hospital. It took 3 pints of blood to bring her around. All I have to do is remember the sound of those screaming tires—and I know why *I'm* giving blood."

Yes, all kinds of people give blood—truck drivers, office workers, salesmen. And—for all kinds of reasons. But whatever *your* reason, this you can be sure of: Whether your blood goes to a local hospital, a combat area or for Civil Defense needs—this priceless, painless gift will some day save an American life!

Business Executives! ✓Check These Questions!

If you can answer "yes" to most of them, you—and your company—are doing a needed job for the National Blood Program.

- ☐ Have you given your employees time off to make blood donations?
- ☐ Has your company given any recognition to donors?
- ☐ Do you have a Blood Donor Honor Roll in your company?
- ☐ Have you arranged to have a Bloodmobile make regular visits?
- ☐ Has your management endorsed the local Blood Donor Program?
- ☐ Have you informed your employees of your company's plan of co-operation?
- ☐ Was this information given through Plant Bulletin or House Magazine?
- ☐ Have you conducted a Donor Pledge Campaign in your company?
- ☐ Have you set up a list of volunteers so that efficient plans can be made for scheduling donors?

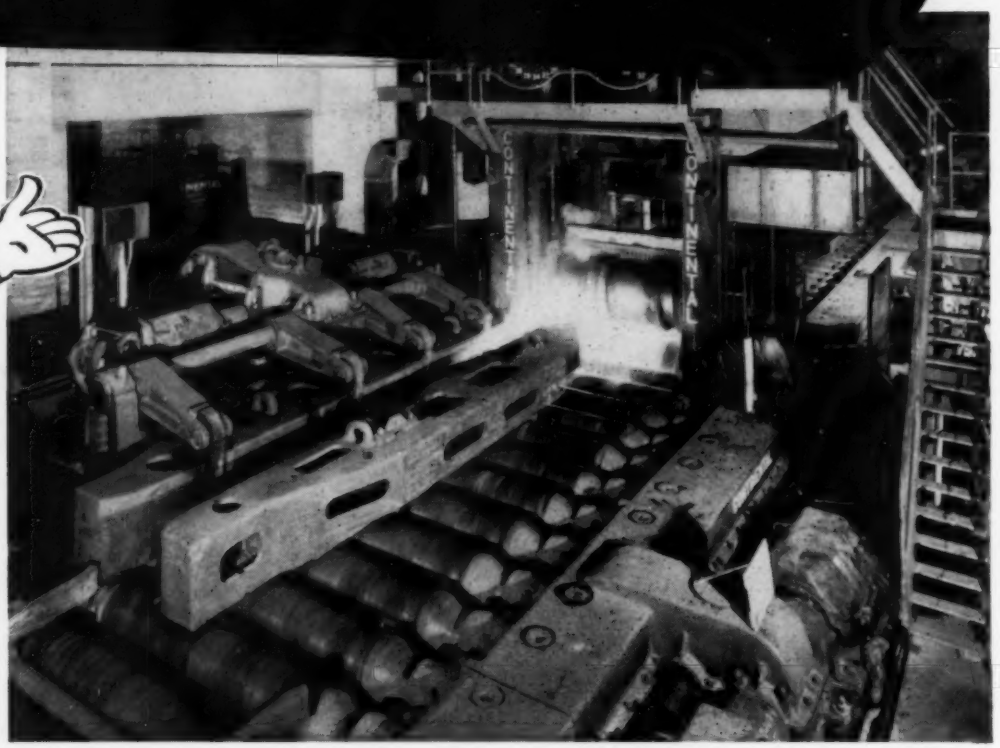
Remember, as long as a *single* pint of blood may mean the difference between life and death for *any* American . . . the need for blood is *urgent!*

Give Blood Now

CALL YOUR RED CROSS TODAY!

NATIONAL BLOOD PROGRAM

how much is lubrication costing you?



This has a BEARING on the subject

It might surprise you if you check your lubrication costs . . . in terms of bearing failure, down-time, repair costs and the insecurity of hand-lubrication. A Trabon Automatic Lubrication System will eliminate these problems and cut your costs enough to more than pay for itself.

For more than 22 years, Trabon has been saving thousands of dollars by automatically lubricating hot mills, tandem cold mills, shears, cranes, welders, coke pushers, blast furnace tops, presses, mill tables, and other machinery.

A Trabon system is *positive*, and a single indicator at the pump gives proof that all bearings are getting just the right amount of lubricant.

So get your metalworking bearings on a Trabon oil or grease system . . . . . .

Bulletin 529 will give you more details. It's yours for the asking.

Trabon Automatic Lubrication Fits Any Bearing Situation.

Trabon ENGINEERING CORPORATION
1814 E. 40th STREET • CLEVELAND 3, OHIO
Oil and Grease Systems

Equipment News...

DUSTLESS MASONRY SAW

▲ Industrial plants throughout the world are reducing costly "down-time" and obtaining better, longer lasting linings by using a dustless Clipper masonry saw to cut special shapes from standard refractory stocks.

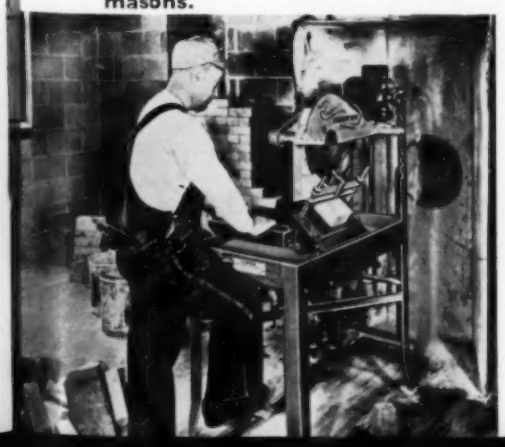
Any of the difficult intricate shapes — end skews, keys, splits, soaps, wedges — needed for furnace, kilns, and boilers can be cut with ease and economy with a Clipper masonry saw. No longer is it necessary to discard "culls" and broken firebrick. With this saw these formerly worthless culls can be salvaged and special shapes produced.

The straight, smooth cuts eliminate hidden fractures and give perfect fitting bricks that reduce the danger of breakouts — only a minimum of mortar is used.

To meet the growing demand for faster cutting of firebrick at lower cost per cut, the Clipper Manufacturing Co., has incorporated several exclusive features into the new model HD. A "pressure equalizer spring" automatically cushions the blade, giving longer blade life. With the patented "select-a-notch" the saw operator can easily adjust the cutting head to any desired height. Other features that are the result of nearly 20 years experience in the field of masonry sawing are: a factory sealed water pump that operates wet or dry; a patented hinge-lock blade guard which serves as a safety device and eliminates water spray when wet cutting.

Maintenance superintendents have found that one operator and a new model HD Clipper masonry saw can keep a full crew of masons supplied with perfectly cut firebrick. Futhermore, with this saw, it is possible to operate the saw next to the job . . . even inside the furnace.

Faster and less costly cutting of firebrick is made possible by this new dustless masonry saw. Intricate cuts can be made to fit the demand for longer lasting lining, and one operator can supply a full crew of masons.



COLD STRIP MILL

▲ Loewy Rolling Mill Division of Hydropress, Inc. is building a 4-high, single stand cold aluminum strip rolling mill for the Wisco Aluminum Corp.

This equipment will produce aluminum strip with a minimum thickness of .010 in. and up to 40 in. wide. Among the features incorporated is the new mechanized coil handling equipment with Hydropress design "finger tip" controls.

BRACKET MOUNTING

▲ A new enclosed-bracket mounting for economically bringing the advantages of beta gage measurement to industries producing wide sheet material has been announced by Industrial Nucleonics Corp., Columbus, Ohio.

Another addition to the versatile line of "AccuRay" beta gage mountings, the new model is designed for use in such industries as paper, plastics, and floor tile where large sheet widths are not uncommon and "crowded" production lines are the rule.

A basic feature of the mounting is the design which permits the source of radiation and detector unit to travel back and forth across sheet on separate arms and never vary their alignment, permitting the same high degree of accuracy provided by other AccuRay models.

Fabricated of welded steel tubing and plates, this standard mounting has been built to handle sheet widths up to 100 in. An outstanding advantage of the unit is its compactness which permits it to be installed without costly alterations in "jammed" production lines. The gage can be installed at various angles to fit slanting pass lines of material.

Company officials state that no change has been made in the "AccuRay's" measuring system which utilizes beta rays to give a direct reading of basis weight or thickness with extreme accuracy.

ALLOY STEEL GRAB HOOK

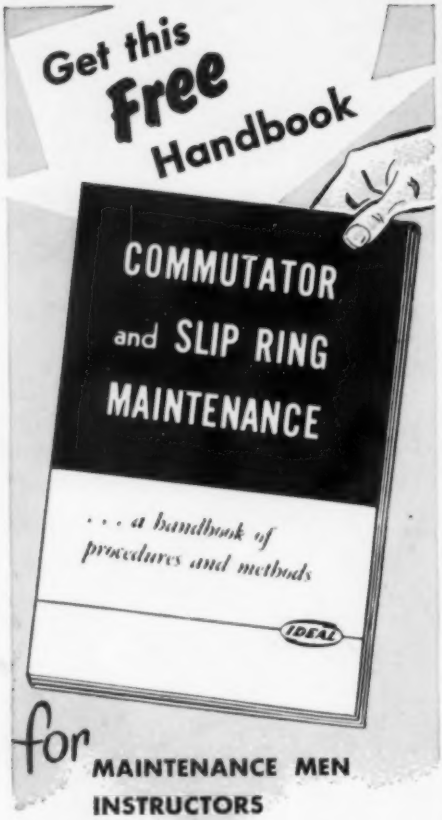
▲ A new type alloy steel grab hook is now being manufactured by the S. G. Taylor Chain Co. The unique design is said to provide additional strength to that which is inherent in

alloy steel. Taylor Chain further announces that all Taylor made alloy steel boomer chains will be equipped with the new alloy steel grab hooks. Requests for individual hooks for boomer chains now in use will also be acknowledged.

LATHE ATTACHMENT

▲ Standard lathes converted to duplicating by hydraulic control offer many advantages in cost reduction as well as producing work better and faster. Machining goes semi-automatic and skilled help is not required. One of the most widely used duplicating attachments for lathes is the Turchan follower, built to suit any combination of feeds, speeds, and tooling that can be used on a lathe. Here is the contour duplicating of an 11½ in. diameter shaped roll of chilled iron—completed in only six hours—compared to 34 hours with the method formerly used.

The important functional feature of this duplicating attachment is that the tool-slide operates at 45-degree



for **MAINTENANCE MEN**
INSTRUCTORS
and TRAINEES
in Motor Maintenance

THE methods and procedures described were developed by recognized, practicing maintenance authorities. They have been proven by conclusive evidence over many years in hundreds of operations. A concise guide, this 39-page handbook tells the practical operating man everything he needs to know about:

- **Commutator and slip ring troubles and how to correct them.**
- **Brush maintenance and operating procedure.**
- **General maintenance procedure.**

Dozens of illustrations show the operations described. Condensed data on IDEAL commutator and slip ring products is included.
Even if you do not have a regular maintenance training program, your people responsible for motor and generator maintenance need, and will do a better job, with the help of this handbook.

NOTE: **This offer is limited to those in plant and other industrial operations. We reserve right to limit quantities furnished. Offer may be withdrawn at any time.**

IDEAL INDUSTRIES, Inc. IDEAL
1045 Park Avenue, Sycamore, Illinois

Please send _____ copies of your free handbook on commutator and slip ring maintenance.

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angle to the work axis. This movement, combined with the longitudinal movement of the lathe carriage, permits the reproduction of prefectly square shoulders, as well as radii and bevels, in exact accordance with any square shoulders, radii and bevels encountered by the tracer as it traverses the template.

An unusually high quality surface finish is attained because the cut is not interrupted, and this method of duplication also affords the elimination of special form tools for turning intricate shapes.

Trial cuts are made with the finishing tool on the first work diameter until a micrometer shows the finished size. The machine is then automatically set to reproduce all diameters from the round model or flat template, so that subsequent measuring is eliminated.

Another important characteristic of Turchan equipment is its ability to reproduce mill roll work uniformly to within .002 in. Tapers, shoulders, grooves, regardless of depth or lengths, and diameters are all reproduced within this limit.

The conventional cross-slide is replaced by one equipped with two compound rests, mounted at 45 degrees to the lathe center line and 90 degrees to each other. Cross and longitudinal travels are actuated by the conventional lead-screws, while 45 degree compound movements are controlled by the tracer. This new combination of movements doubles the function of tools on any standard lathe.

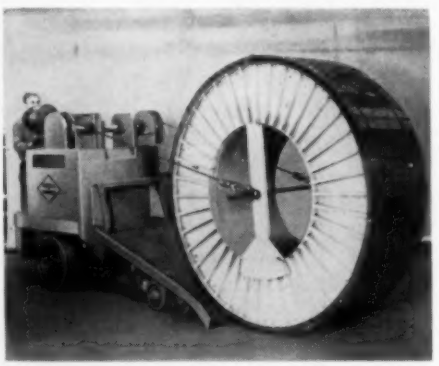
Parts with contours on the diameter or face can be duplicated, as well as a combination of both. The lathe is operated in the conventional manner, none of its standard controls being removed. To change from one angular slide to the other, a single change-over lever is provided, which also indicates the direction of duplicating. Only one slide is used at a time; the other remaining in locked position. Thus square, right, and left-hand shoulders, including undercuts and radii, can be machined.

PLATFORM TRUCK

▲ Designed for handling large reels up to 96 in. in diameter and weighing up to 20,000 lb, this specially designed powered platform truck is equipped with a rocking platform and a powered winch. The truck is manufactured by Elwell-Parker Electric Co. Other models, designed for reels weighing 6000, 10,000 and 12,000 lb are also available.

In operation, the truck is moved to a reel standing on the floor. Dual cables, connected to the powered winch on the vehicle, are attached to the pin running through the center of the reel. The winch is used to pull the heavy loads onto the rocking platform of the truck. As the roll strikes a horizontal bar located on the front of the battery compartment, power to the winches is automatically cut off — an important safety feature.

Even when the reel is on the truck the rocking platform is always fixed in a slightly tilted position away from the truck so that when the cable is slackened, the reel rolls easily but safely onto the floor. Thus, the cable always controls the discharge of the reel, so there is no danger of the heavy loads getting out of control.



Equipped with a rocking platform and a power winch, this newly-designed powered platform truck is capable of handling reels up to 20,000 lb. and 90 in. in diameter.

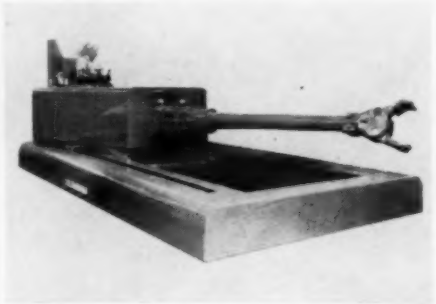
Additional winch features: an overload slip clutch on the winch motor prevents shaft damage; it is also equipped with a worm gear reduction unit.

The platform truck is available with either power or hand-wheel steer. The size of the platform and the wheel base may be varied depending on the diameter of the reel handled. The truck has all-wheel steering for maximum maneuverability and is powered by battery or a gas-electric unit. It is also equipped with "deadman" control.

CHARGING MACHINE

▲ A new charging machine, engineered for operation by remote control, is being manufactured by the Columbiana Engineering Co. Outstanding

advantages of this unit are: (1) the remote control feature enables the operator to exercise control over the numerous motions directly within reach; (2) there are no obstructions to operator visibility; (3) the design of the machinery is simplified and compact; (4) the amount of hydraulic piping is considerably reduced; and (5) motion approaching servo-control is obtained.



The remote control mechanism has been developed because, in the design of a charging machine or forging manipulator, it is necessary to use a system of manual control to obtain positive motions during a short interval of time.

Here is an example of how the remote control charging machine operates. At one company, for example, it is used to take cold steel billets weighing up to 3000 lb from the floor or storage piles, then charges them into furnaces. On being heated to 2300-2450 F, the billets are taken from the furnace, transferred to a 5000-ton hydraulic press and dropped into the die cavity. The machine is also employed to remove the finished forgings from the press.

The charging machine operator has to control two electric and four hydraulic motions in addition to open and close furnace doors and operate a descaler which removes scale from the heated billets.

The remote control operates as follows: opposing springs of equal force in the transmitter and receiver, "balance" the control and eliminate lost motion and backlash. Fluid pressure in the system approximates 200 psi. On the pressure stroke, movement of the transmitter handle to the left forces its piston downward displacing hydraulic fluid from the transmitter cylinder through the connecting tube and into the receiver cylinder. This forces the receiver piston upward and simultaneously moving the receiver lever the same number of degrees as the transmitter handle. On the return stroke, the transmitter spring is compressed and the hydraulic fluid (now under pressure of the receiver spring) is returned from the receiver cylinder to the transmitter cylinder, moving the receiver lever the same number of degrees as the transmitter handle.

A unique synchronization feature is employed to compensate for any temperature variation resulting in volumetric changes of fluid between pistons, and loss of synchronization. Any change in fluid volume can be compensated for, easily and instantly. Moving the transmitter handle through its seven-degree over-travel position operates the tripper lever and opens the valve. This releases fluid from the reservoir into the system or permits the return of excess fluid to the reservoir.

PORTABLE UNDERCUTTER

▲ The new Martindale "Model H Mica-Miller" is an excellent all around undercutter as it is completely portable, can be used on a wide variety of jobs, and can be operated on either a-c or d-c.

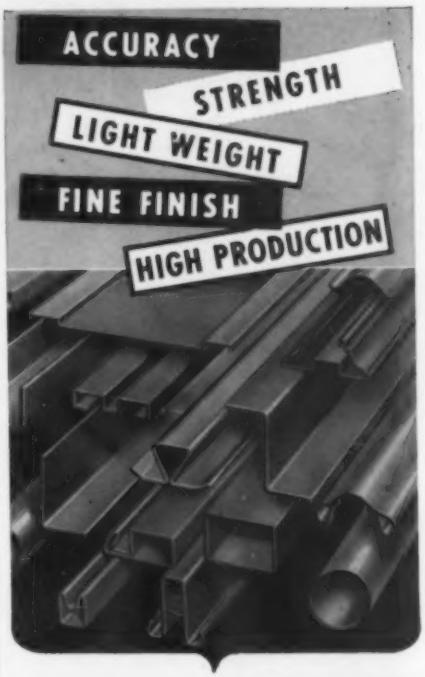
The model is of sturdy construction

yet light in weight (7¼ lb). It is well balanced and easy to operate. Driven by a powerful 1/5 hp motor at 2800 rpm full spindle speed with the "standard" head, the model does rapid, accurate work and cuts either "U" or "V" slots.

Three interchangeable heads — "Small" — "Standard" — and "Heavy Duty" — are available for the model, which make it possible to use the undercutter with saws or "V" cutters ranging from $\frac{23}{32}$ in. to 1¼ in. outside diameter to undercut a wide variety of commutator sizes.

All three heads are equipped with

(*Please turn to Page 232*)



COLD-ROLL-FORMING

gives you all of these advantages

At lower Cost—

● In busy metal working plants, vigilant production men are constantly on the lookout for places where, due to increased demand for their products, the time is ripe for a change of methods. They know that in the shaping of metals into finished products or components, cold roll forming has many important quality and cost advantages over all other methods.

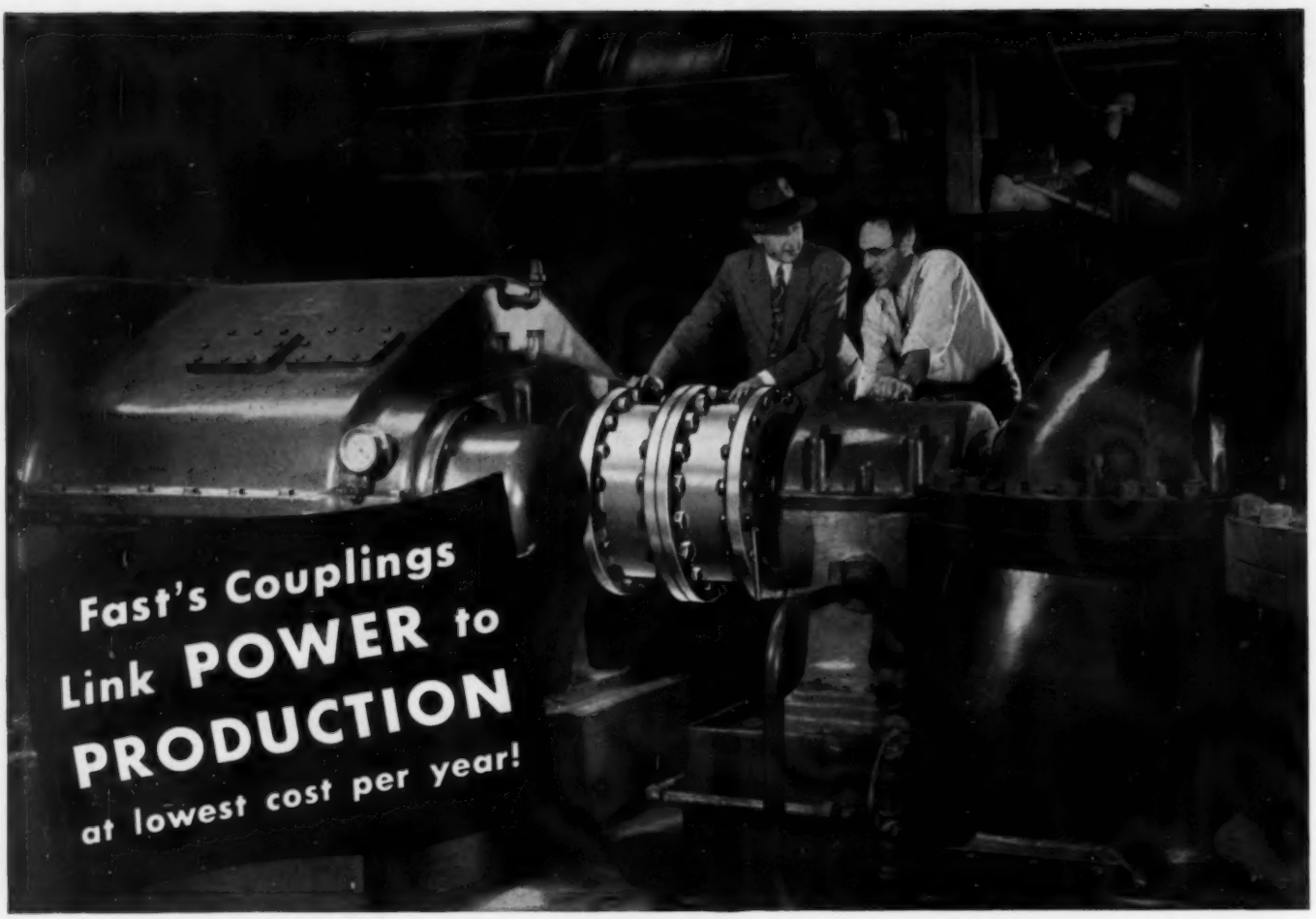
In some instances it becomes possible, by redesign of the product, to adopt cold roll forming. In others, the mere need for higher production makes the change profitable. Again, redesign often leads to a saving in weight which, in the case of the more expensive metals, alone may amount to much more than the conversion cost.

When such changes are indicated, feel free to avail yourself of the Yoder engineering service in analyzing and determining the practicability of cold roll forming, choice and cost of equipment, and other pertinent questions.

THE YODER COMPANY
5495 Walworth Ave., Cleveland 2, Ohio

Cold-Roll FORMING MACHINES

ENGINEERING YODER MANUFACTURING



Over half a million FAST'S Couplings now in use!

THROUGHOUT industry, Fast's are rated the most dependable couplings on the market . . . to the tune of over half a million now in service! Year in, year out, they continue to *outlast the equipment they connect* . . . save time, maintenance and money by eliminating costly coupling failures.

Actual cases on record show many Fast's Couplings have been in operation for 25 and 30 years without trouble. And every major producer of high-speed equipment now uses Fast's!

Solve your coupling worries! Write today for full details on Fast's Couplings and Koppers Engineering Service to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 211 Scott St., Baltimore 3, Maryland.

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

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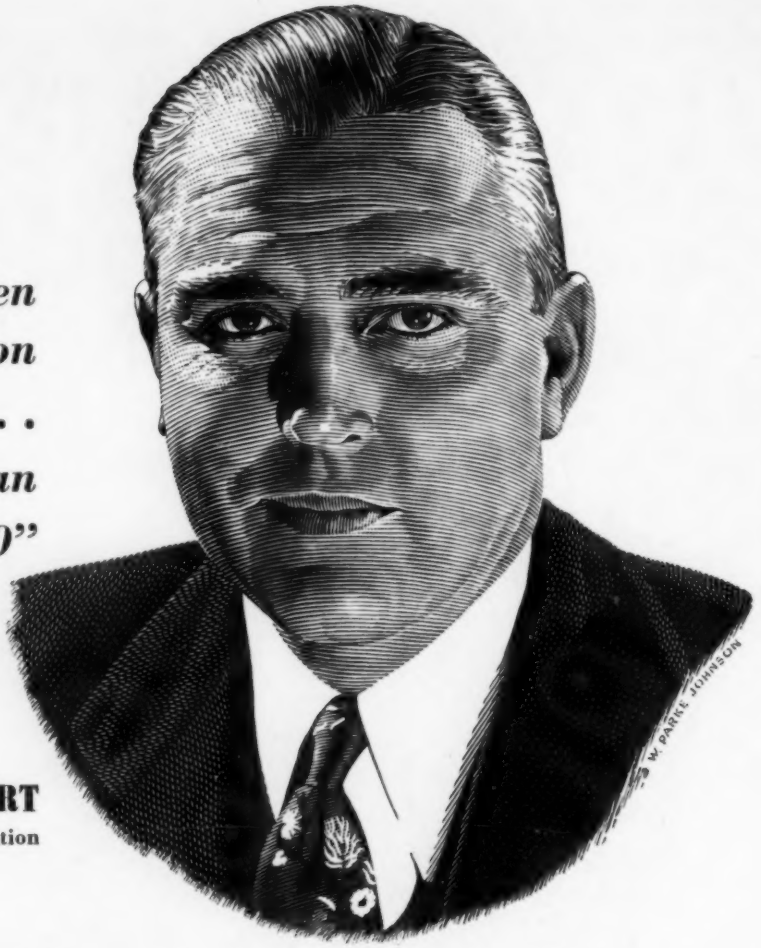

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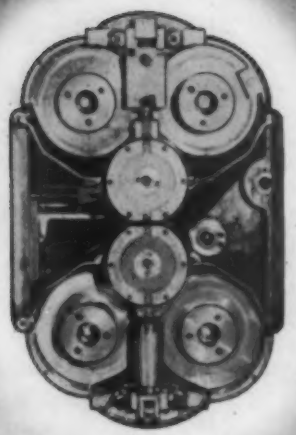

Side view of roll arrangement in Sendzimir Cold Sheet Mill shown

Photos courtesy of Atlas Steels Limited, Welland, Ontario

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depth-gages, the two smaller ones have slot guides and the heavy-duty head has roller supports.

In the illustration "Mica-Miller" is equipped with a "Standard" head. The "Heavy-Duty" head is shown at the side.

RAPPING SYSTEM

▲ Electrode rapping is an essential part of electrostatic precipitator operation and maintenance. Precipitators are used to clean gases from blast, open hearth, electric, and iron ore sintering furnaces. They have proven highly efficient in the job of reducing nuisance emissions and in recovering valuable suspended materials otherwise lost to the atmosphere.

The gas cleaning work is done chiefly by the precipitator's electrodes. There are two sets of these electrodes in a precipitator shell, the high tension discharge electrodes, and the collecting electrodes. The gas to be cleaned flows through the electrical field set up by the discharge electrodes. Suspended materials in the gas become electrically charged and attracted by the grounded collecting electrodes.

However, all of the dust collected by the collecting electrodes does not fall by gravity into the disposal hoppers. Some of it remains on the electrodes to build up into appreciable layers in a relatively short time, particularly on the collecting electrodes. Dust build-ups on electrically charged electrode surfaces will affect the efficiency of the precipitator. Electrode rapping unloads these accumulations to restore the precipitator to its initial operating efficiency.

Up to now standard equipment for electrode rapping consisted of mechanical and pneumatic rapping devices. Practical considerations limit electrode cleaning with this type of equipment to an intermittent operation. Electrode cleaning, therefore, is a bath removal process, rather than a continuous operation which would keep precipitator efficiency at constant high level. Another advantage of continuous rapping is that the size of the unloaded dust aggregates are kept small enough at all times to prevent dust clouding in the equipment, which sometimes occur with batch removals under periodic rapping conditions.

A recent development by Research Corp. now offers precipitator users a rapping system for continuous electrode cleaning. It is a magnetic-impulse rapping system which delivers continuous rapping impacts of light and easily controlled intensities. The rapping method uses a solenoid-actuated rapper energized by a pulse generator, instead of a mechanical or pneumatic rapping device as in other rapping systems.

The rapper can be easily installed on any standard electrostatic precipitator used in electric, blast, cupola, open hearth and iron ore sintering furnace installations, and for fly ash, gypsum and cement applications as well.

A central pulse generator can deliver tripping impulses to each of the rapping units — up to 24 per precipitator — at intervals of 2½ seconds to

(*Please turn to Page 234*)

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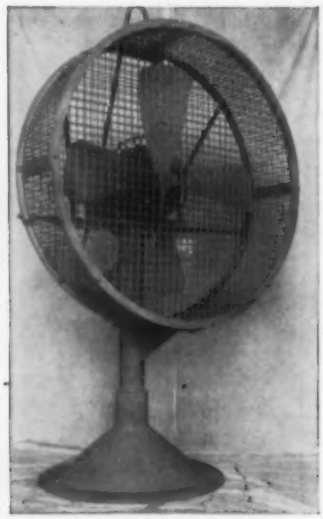

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EQUIPMENT NEWS

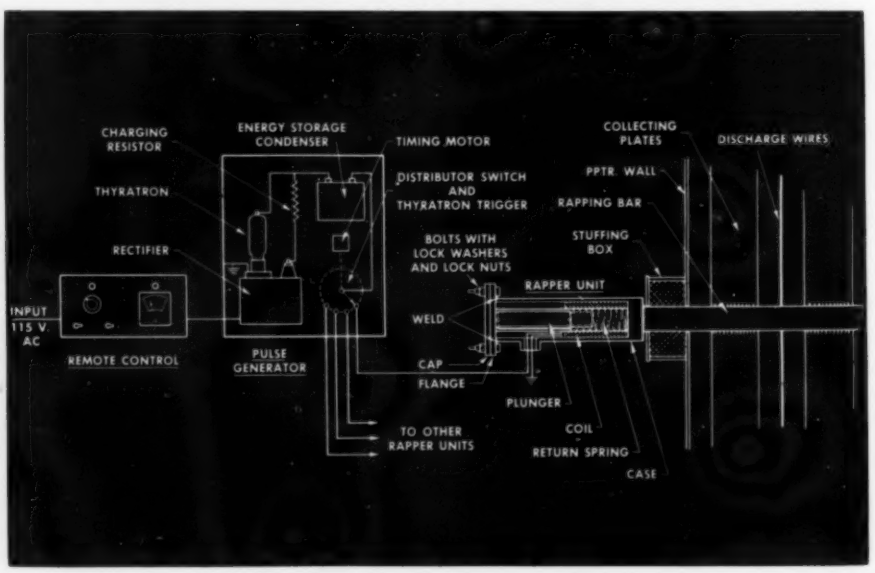
(*Continued from page 232*)

rap the entire precipitator in 60 seconds or less. Power consumption is low — 300 watts or less per precipitator. This means low operating cost and low power capitalization costs. A separate remote control unit permits monitoring of the rappers from any convenient plant location to eliminate the need for any regular operating personnel.

LIGHTWEIGHT MOTOR

▲ A new development in single phase variable speed motors in fractional horsepower is announced by U. S. Electrical Motors Inc. As a modification of the company's Type VA "Varidrive" line, the new motor permits use of 110 or 220 volts. It is designated as Type VA-C and is made in ¼, ⅓, ½ and ¾ hp. This compact, lightweight motor provides speeds in a 10:1 ratio with the range from 4 to 10,000 rpm. Merely by turning a convenient control dial, the motor's speed can be instantly changed to a desired speed without stopping.

Schematic circuit of power supply unit that energizes rappers.



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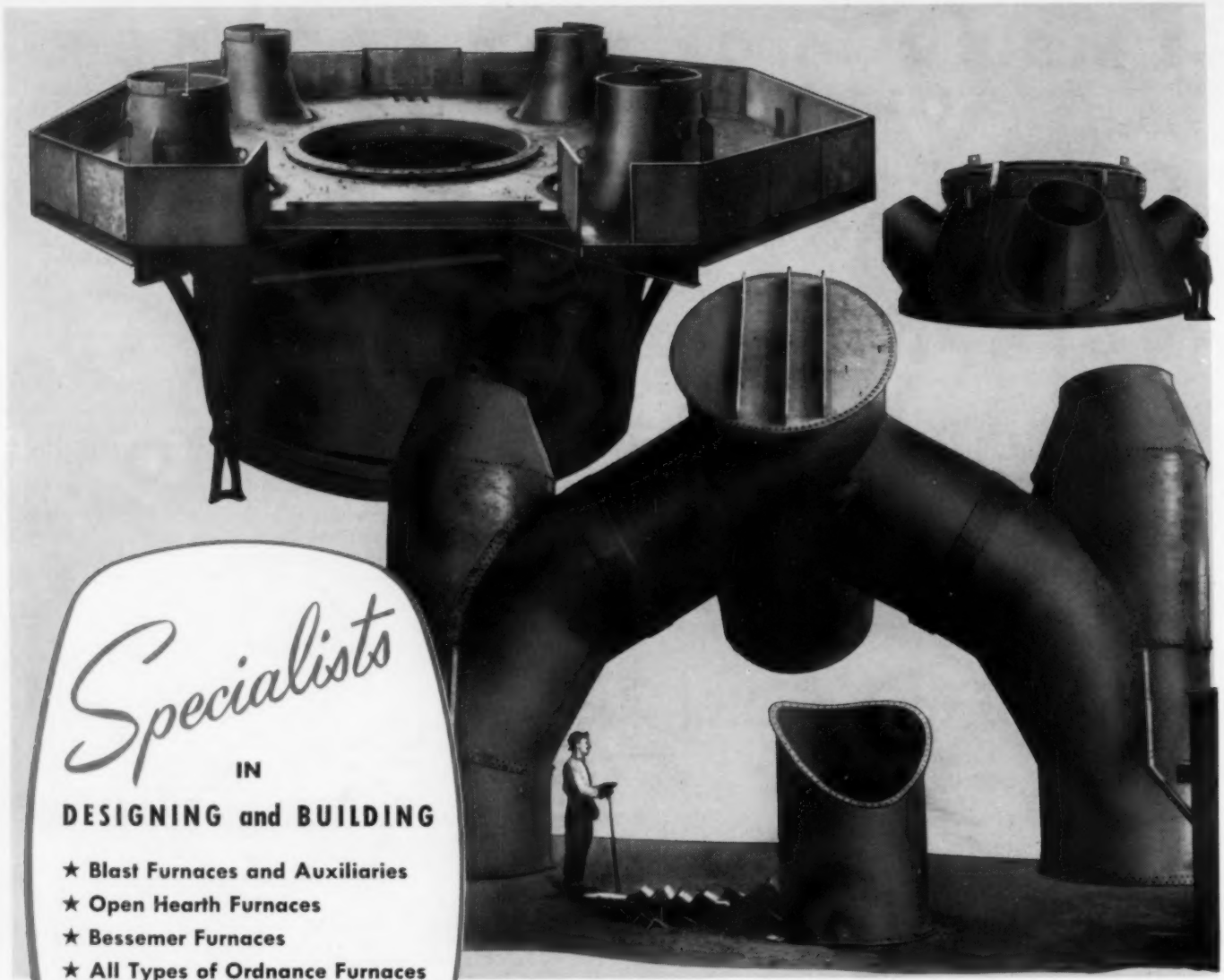

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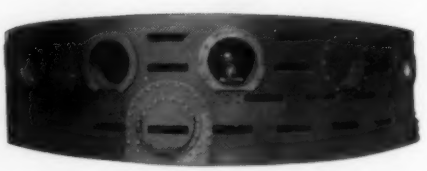

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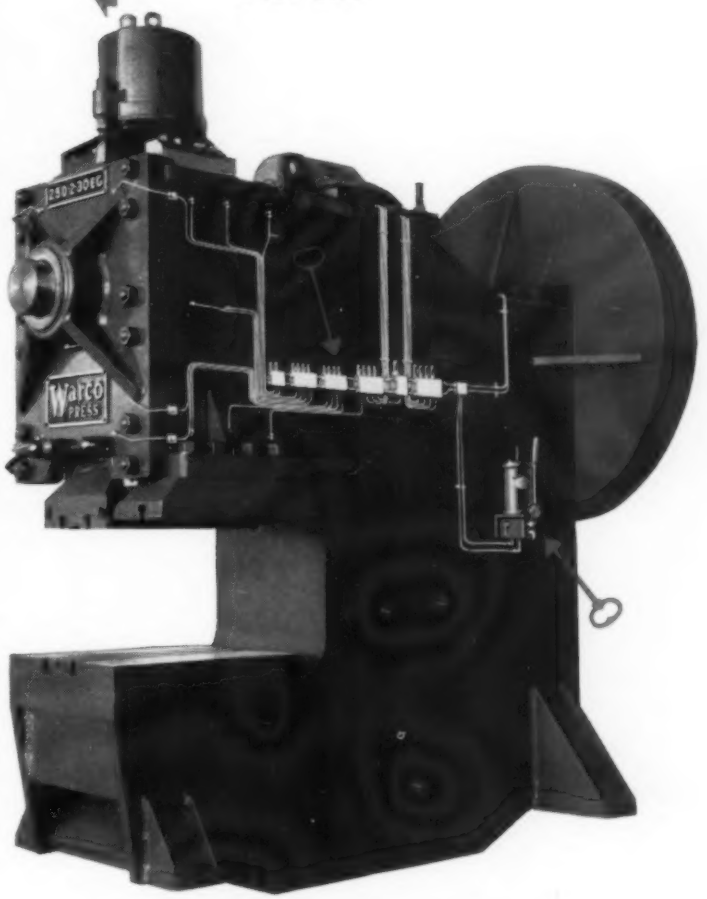
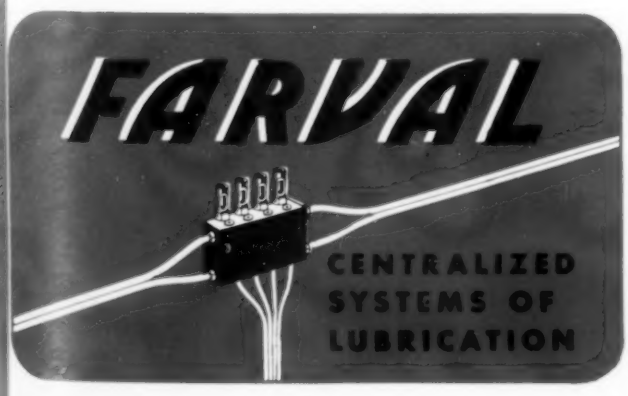


KEYS TO ADEQUATE LUBRICATION — Wherever you see the sign of Farval—the familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine will be properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.

Photo above by courtesy Federal Machine and Welder Co.



Driving screwdowns on the 70-mph 5-stand cold strip mill at Jones & Laughlin's Aliquippa Works are 10 G-E 75-hp MD mill motors. On ingot buggies, sideguards, tables, and other auxiliaries, too, G-E MD motors give high service continuity.

G-E mill motor, with improved ventilation, lasts longer in steel-mill service

Totally enclosed mill motor dissipates up to 50% more heat; resists corrosion, heat, moisture

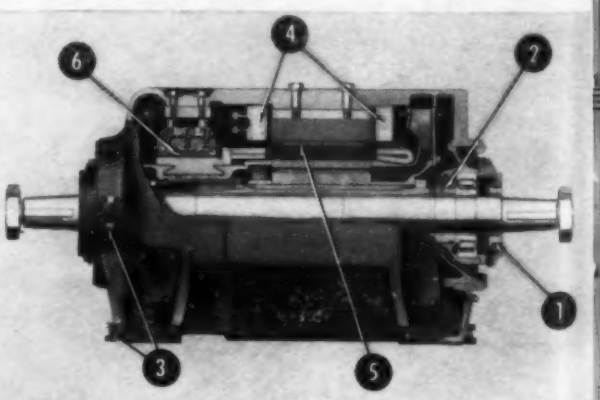
For longer motor life, fewer replacements and less downtime, General Electric MD-600 totally enclosed mill motors are built to last in all kinds of steel-mill conditions—intense heat, corrosive fumes, excessive moisture and mechanical strain.

Take ventilation, for example. An improved system for circulating internal air carries more heat away from the armature, dissipates it through the frame for increased efficiency. Heat-dissipating ability—increased up to 50 per cent—gives a greater margin of safety, helps increase motor life.

You get best results when G-E application engineering teams up these heavy-duty d-c mill motors with co-ordinated G-E control and fast-acting G-E magnetic brakes. For more data, contact your nearest G-E Apparatus Sales Office and ask for Bulletin GEA-4654, or write to General Electric Company, Section 659-87, Schenectady 5, N. Y.

Built extra-tough for extra-tough jobs!

1. Four grease-packed grooves in each end of frame heads keep grease in, dust out.
2. Grease slingers on shaft further protect commutator and windings against possibility of escaping grease.
3. Wide-spread pads at frame joint, and tongued and grooved pads on feet, insure firm support and mounting for brake.
4. Heavy mica and glass insulation, plus insulating pads of waterproof oiled asbestos, protect field coils.
5. Full-length commutating poles for improved commutation permit momentary loads up to 300%.
6. Box-type brush holders, anchored in place by two insulating studs, lessen wear on brushes



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